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Pesticides Abstracts and News Summary

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INSECTICIDES

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COLONIAL PESTICIDES RESEARCH COMMITTEE
COLONIAL OFFICE, LONDON

The abstracts contained in P.A.N.S. are in general abstracts of interim reports. The conclusions stated are, therefore, tentative and may be modified by the results of subsequent investigations.

Permission to quote from these abstracts or the original papers must be obtained from the authors.

[redacted]

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NEWS ITEMS - GENERAL

SPECIFICATIONS AND METHODS OF ANALYSIS FOR CERTAIN PESTICIDES

"In 1934, the Association of British Insecticide Manufacturers prepared specifications and methods of analysis for certain insecticides, and fungicides, including lead arsenate and lime sulphur, and these were published by the Ministry in Bulletin No. 82. This was the beginning of a pleasant and productive collaboration which has continued ever since through the medium of joint committees set up by the Ministry and the Association. The first two editions of this bulletin (issued in 1949 and 1951) brought together under one cover all the specifications and methods of analysis which had been drawn up by the various committees. In the present edition a few of these have been revised, others have been added, and the text has been rearranged into three distinct parts dealing respectively with specifications, methods of analysis, and a miscellany. An index has been added."

(Ministry of Agriculture, Fisheries and Food. Plant Pathology Laboratory. London, H.M.S.O. 1958. 3rd edition. pp. x + 126.)

COMMONWEALTH AGRICULTURAL BUREAUX.
TWENTY-NINTH ANNUAL REPORT OF THE EXECUTIVE COUNCIL 1957-58

Summaries of the Annual Reports of the Directors of Commonwealth Institute of Entomology, Commonwealth Mycological Institute, Commonwealth Institute of Biological Control and the Commonwealth Bureaux, are given.

The following items are noted from "Notes of Progress in the Agricultural Sciences, by Directors":

Molluscicides

"It looks as if copper sulphate for the destruction of molluscan vectors may soon be replaced by pentachlorophenol, which is not so readily neutralized in certain types of water, unless on further research one of the abietylamines, now used in large quantities as an algicide proves more effective. It is readily available and relatively low in cost."

Reservoir Hosts.

In Africa and in South America, Schistosoma mansoni has been found as a natural infection in rodents.

LOCUST RESEARCH AND CONTROL 1957-58

Anti-Locust Research Centre.

Desert Locust Control

Substantial progress was made on further development of aircraft spraying, the tests of a new insecticide, diazinon, having produced exceptionally good results. Large-scale tests of the method of controlling hoppers by the application of a residual insecticide to vegetation by means of an exhaust sprayer, carried out in Libya by invitation of the Libyan Government, proved to be a great success; the method is gradually replacing baiting in suitable conditions and it promises to result in considerable economy, due to the elimination of expenditure on the transport of large quantities of bait.

Since movements of non-swarming populations of the desert locust occur mainly during nights with certain temperatures, an investigation is being made of the distribution of night temperatures within the desert locust region with a view to delimiting areas which might be suitable for night flights at different times of the year. This work is expected to throw light on the dynamics of low-density locust populations, and their part in the development of locust plagues.

THE PRACTICAL ASPECTS OF FORMALDEHYDE FUMIGATION

"Under optimum conditions formaldehyde is lethal to bacteria, bacterial spores, viruses, fungi and yeasts (Nordgren 1939, Report 1958) and has been employed as a fumigant, with a variable degree of success, for the past sixty years. Conflicting reports, however, raised doubts about its reliability and, for a time, it fell into disuse. The recent attention given to hospital hygiene and the sterilization of bedding has re-awakened interest in the use of formaldehyde. It is the purpose of this note to set out its capabilities and limitations as a disinfectant to indicate the conditions necessary for effective use, and to give practical details of techniques. It must, however, be stressed at the outset that the difficulty of realizing the essential conditions in practice restricts the applications of formaldehyde disinfection.

Formaldehyde has the advantages of being cheap, easy to handle, not injurious to fabrics, paints or metal, and of being rapidly neutralized by ammonia. Its pungent and irritating odour gives adequate warning of its presence at concentrations (5 p.p.m.) too low to be toxic. Air containing more that 7% formaldehyde is a potentially explosive mixture, but such concentrations are never likely to be produced during fumigation. For formaldehyde to act as a disinfectant it must dissolve, at adequate concentration, in a film of moisture in the immediate vicinity of the organisms which are to be killed. The factors which determine the formation of this lethal micro-environment and control the rate of killing are (i) the concentration of vapour which can be maintained (ii) the temperature, (iii) the relative humidity of the atmosphere, (iv) various impediments to the penetration of the gas.

Purposes for Which Formaldehyde is Recommended

Disinfection by formaldehyde fumigation, unless it is to be inconveniently prolonged, has not the same margin of safety as disinfection by heat or chemical agents in solution. Formaldehyde should not, therefore, be used when any more certain method can conveniently be applied. We should not recommend it for any application where the killing of all pathogenic organisms is imperative, e.g. for surgical instruments, or the disinfection of the bedding of smallpox patients. The three applications for which formaldehyde seems most suitable are the disinfection of:-

(1) Rooms from which fabrics have been removed. A gas or vapour is commonly the only possible agent for this purpose.

(2) Small objects which cannot be heated or wetted without damage, such as respirators, leather goods, boots, and toys not made of fabric.

(3) Mattresses and woollen blankets. If these are spread out to allow access of the gas, surface disinfection is possible at room temperature, but if disinfection of the interior of the mattress or of folded blankets is required, some form of heated chamber must be used."

Techniques are described for disinfection of rooms, disinfection of small objects in a chamber, disinfection chamber for fabrics (unheated) and a heated chamber, for fabrics. "The techniques described are simple and have proved effective in our hands, but we strongly recommended that bacteriological tests be applied when any procedure using formaldehyde is first put into operation. The techniques may be expected to sterilize objects and surfaces contaminated by air-borne particles containing small numbers of organisms lightly protected by organic matter. Objects heavily contaminated with organisms which are protected by dried organic material, such as serum, will not be invariably sterilized, though a substantial reduction (99.99% killed) in the number of viable organisms may be expected."

(Monthly Bull. Min. Health and Public Health Lab. Serv., Dec. 1958, 17, 270-273).

AGRICULTURAL RESEARCH IN THE U.S.A.

Saving Cotton Seedlings. (a): U.S.D.A. in cooperation with the Texas Agricultural Experiment Station, has developed a method for protecting cotton seedlings from soil-borne fungi by treating the soil with fungicides at planting. The method depends on the mixing of fungicides, either as dusts or sprays with the soil in the furrow which is $\frac{3}{8}$ in. wide at its base and 2 in. wide at the top. The top soil of the furrow is also treated.

Existing planting equipment can be adapted to apply these fungicides. The planter is equipped with V-wings wide enough to control the flow of soil past the furrow opener. If practicable a runner-type opener is used as it firms the furrow walls and allows covering devices to crumble only treated soil into the furrow. A narrow-bottomed opener on the planter keeps the seed from shifting from the middle of the area treated. Fungicide is applied both ahead and behind a seed firming wheel when such a device is used.

When applying spray, low-pressure power equipment can be adapted by installing a regulator to hold pressures at 35-40 p.s.i. The front nozzle is centered on the furrow so that spray strikes the soil around the seed and 3 inches on each side of the furrow. Spray from the rear nozzle is directed into soil thrown into the furrow by covering devices. The effectiveness of this treatment is increased by thinner spacing of seed, 25-30 lb/acre, which lessens the spread of fungi.

Induced Increase of Soft Scale. (b): The principal natural enemies of soft scales (the frosted scale, the European fruit lecanium, and the calico scale) attacking walnut trees in northern California are small winged parasites easily killed by trace amounts of insecticides. If undisturbed, the parasites are able to maintain the scale population much below an economic level.

The systemic insecticides, demeton (Systox) and schradan (OMPA) have been associated with an increase in the scale problem. In experimental plots, where demeton was used, in combination with the codling moth spray, to control the walnut aphid, highly destructive scale populations developed. Schradan tends to hold the soft scale population, except that of the calico scale, in control. The action of schradan tends to increase the calico scale population with the number of years that it is applied.

"Why systemic insecticides should result in an increase of soft scales is not known. Some physiological or physical action might be involved or the chemicals may in one way or another interfere with parasitism. It is possible that scales surviving specific treatments suck up sufficient amounts of the systemic materials to become toxic to many of the developing parasites."

Effect of Pesticides on Bees. (c): Important losses to beekeepers, and especially to agriculture in general - since honey bees have been estimated to be far more valuable as pollinators of agricultural crops than as a source of honey and beeswax - have been caused by certain pesticides appearing on the market during the last few years. The contact effects of many pesticides on honey bees have been studied in laboratory and field tests. The relative toxicity of many of the new pesticides to honey bees are shown in the accompanying table. The toxicity rating of each material was based on the normal dosage recommended for field application.

"The materials included in Groups 1, 2 and 3 are primarily contact poisons, but they may also act as stomach poisons to bees, therefore, special care must be taken to avoid contaminating water or food available to bees. That same problem may exist with Dylox and Systox in Group 4. In the presence of water Dylox changes to DDVP, a more toxic compound. Arsenicals are stomach poisons to honey bees and may be stored in the colonies, causing continued killing of brood and bees. Some of the chemicals not only kill many bees but also disorganize surviving bees to a point where they neglect their duties to such an extent that death of the brood results.

The materials in Group 2, although highly toxic, can be used around honey bees because of certain characteristics they have. TEPP and Phosdrin have such short residual activity they kill only the bees contacted at treatment time; thus these materials are safe to use when the bees are not present in the field. Thimet and Di-Syston are used as seed and soil treatments and therefore do not present a problem. Sabadilla is used in such low dosages, particularly on citrus, that it presents no problem. Malathion is inconsistent in toxicity to bees. Many thousand acres of blooming alfalfa have been treated with malathion without serious loss to colonies, but occasionally heavy losses do occur, particularly under extremely high temperatures. Thus, its use around bees is questionable.

Recent observations indicate that bee losses are low when highly toxic materials are used no closer than one quarter mile to colonies or blooming fields. When pesticides toxic to honey bees are used in the field, they should be applied in the early morning or late evening, when the fewest bees are present. Pesticides should not be applied over colonies when the bees are hanging outside as they may do during hot weather. The exact time of day for treatment depends on many variables - such as crop attractiveness, time of year, weather conditions, behaviour of bees, and so forth - and must be determined for each particular case."

Group 1

Highly toxic materials that should not be used when there is a possibility of poisoning bees at treatment time or within a few days thereafter.

Aldrin
BHC
Calcium Arsenate ø
Chlordane
Chlorthion

DDVP
Diazinon
Dibrom
Dicapthon
Dieldrin 1)

DNOSBP (DN-211)
EPN ø
Guthion ø
Heptachlor
Lead Arsenate ø

Lindane
Metacide ø
Methyl Parathion ø
Parathion ø 1)
Sevin 1)

Group 2

Highly toxic materials that can be used around bees when certain precautions are used.

Di-Syston ø
Malathion 1)

Phosdrin ø 1)
Sabadilla

TEPP ø
Thimet ø

Group 3

Moderately toxic materials that can be used around bees if timing and dosage are correct, but should not be applied directly on the bees in the field or at the colonies

Chlorbenzilate
Co-Ral
Cryolite
DDD (TDE)

DDT 1)
Endrin 1)
Ethion (Nialate) 1)
Isodrin

Korlan
Perthane
Tartar Emetic
Tedion

Thiodan 1)
Toxaphene 1)
Trithion 1)

Group 4

Relatively non-toxic materials that can be used around bees

Allethrin
Aramite
Bordeaux Mixture
Captan 2)
Copper Oxychloride
Sulfate
Copper Sulfate
(Monohydrated)
Cuprous Oxide 2)
Cunilate
Delnav 1)

Dilan
DMC
DNOCHP(DN-111)
Dylox (Dipterex)1)
Ferbam 2)
Genite 923
IPC 2)
Karathane
Kelthane 1)
Maneb 2)
MCP 2)

Methoxychlor
Mitox
Monuron (CMU)
Nabam 2)
Neotran
Nicotine
OMPA
Ovex (Ovotran)
Phostex
Pyrethrins
Rotenone

Ryania
Sulfur
Sulphenone
Systox
(Demeton) ø 1
Thiram 2)
Zineb 2)
Ziram 2)
2,4-D ø 2)
2,4,5-T ø 2)

ø Permit required by State regulation for most uses of these materials. Permit for 2,4-D and 2,4,5,-T as weed treatments but not as hormone sprays on citrus.

(1) These materials field and laboratory tested; all others just laboratory tested. Further field testing may change the group location of some of the materials.

(2) Data obtained from other research workers.

Fly and Tick Control. (d): In a supplement to Agricultural Handbook No. 120. (Feb. 1958) the U.S.D.A. now recommends the use of Bayer 21/199 = Co-Ral = Asuntol, for the control of certain livestock pests; e.g. on beef cattle for controlling cattle grubs, horn flies, lice, ticks, keds, and screwworms and on swine for the control of lice and screwworms. It is not recommended for dairy cattle or milk goats.

(a) Agricultural Research, Nov. 1958, 7, (5), 10-11.

(b) A. E. Michelbacher and S. Kitchcock. California Agric., Nov.1958, 13.

(c) L. D. Anderson and E. L. Atkins, Jr. California Agric., Dec. 1958, 3-4.

(d) U.S.D.A. Agricultural Research, Sept. 1958, p.15).

COMMUNICABLE DISEASES CENTER, REPORT OF ACTIVITIES JULY 1956 to JUNE 1957.

U.S. Department of Health, Education and Welfare, Public Health Service.

Fly Control

Satisfactory control of houseflies in dairy barns near Savannah, Ga., was obtained with the following residual deposits per square foot:

100 mg. diazinon (alone or with 250 mg. sugar	6-8 weeks
20 mg. diazinon - 50 mg. sugar	4 "
100 mg. Dipterex - 250 mg. sugar	8 "
25 mg. EPN - 200 mg. DDT	13 "
200 mg. Dow ET-14	9 "

Mosquito Larvicides

Preflood and postflood residual larviciding with DDT, dieldrin, and heptachlor prevented mosquito production in areas near Chinook, Montana, for periods ranging from about two months to a full season. Residual larvicides applied in a one-mile zone around Chinook were effective in reducing the mosquito population in town during the beginning and end of the season, but biting rates remained high during the midsummer peak.

Production of log-pond mosquitoes in Oregon was effectively controlled for periods up to three months with residual larviciding applications of dieldrin, heptachlor, and DDT. Small amounts of Dipterex were temporarily effective.

Disinsection of Aircraft

Studies on residual applications for aircraft disinsection have been made with DDVP (dimethyl 2, 2-dichlorovinyl phosphate). Tests were made in an air-conditioned simulated aircraft passenger compartment furnished with material actually used in passenger aircraft.

An efficient and adaptable cone-type wick vapourizer was developed for dispensing DDVP. It was found that 100 mg. of DDVP vapourized in 30 minutes with one air exchange every 3 minutes killed 95 to 100% of the adult female houseflies in the compartment and that vapourization of 12.5 gm. DDVP in 30 minutes gave satisfactory residual control of houseflies for 24 hours. Different materials in the compartment showed variation in their sorption of DDVP, with the wainscoting, headliner plastics, and other surfaces not normally contacted by passengers adsorbing more than the upholstery.

Spray Nozzles

Field observations indicated that poor spray nozzle performance might be due to nozzle orifice corrosion during storage. Improved test procedures were devised, particularly for nozzle tips. It was found that corrosion of hardened stainless steel nozzle tips did not seriously affect spray patterns.

Dieldrin Detection Test Kit

A test kit was developed for the detection of dieldrin sprays on clay walls and other similar building materials. After a number of coloured dyestuffs had been tested, it appeared that a fluorescein dye most nearly met requirements. Several kits containing capsules of fluorescent dye, a sampling tool, and a test tube have been prepared for overseas evaluation of the detectability of the dye on various clays and on the longevity of the dye under various climatic conditions. Each capsule will colour three gallons of spray and will increase the cost of materials for the test by one cent for each pound of dieldrin used.

Schistosomiasis Control

In Puerto Rico sodium pentachlorophenate is the most effective molluscicide so far. In general, the number of snails infected with S.mansoni ranges from 0 to 4.5%, and in those areas where comparative data are available for a sufficient time period to permit recognition of a trend in infection rate, the application of sodium pentachlorophenate has reduced the snail population to about 30% of the pre-treatment level.

Herbiciding and drainage are two other approaches to snail control and since November 1955 monthly surveys have been made to evaluate these influences upon an extensively distributed population of A.glabratus in a swamp. Herbiciding had little adverse effect on the vegetation, but destroyed 80% of the snails. The population gradually recovered, however. The heaviest vegetation was then cut and removed, the water level was lowered about 1 foot, the remaining vegetation gradually died, and the result has been the disappearance of all A. glabratus in the test plot.

Studies also continued on the competition between Australorbis glabratus and species of Helisoma, Ampullaria, Marisa and Tarebia. The most promising species for biological competition is the ampullarid Marisa which may make impounded water unsuitable for Australorbis maintenance or introduction since it readily destroys stands of lily pads, a favourite place for Australorbis ovipositing.

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

Green Mould of Citrus: "Solutions of sodium o-phenylphenate control green mould wastage (due to *Penicillium digitatum*) but can cause rind injury in oranges. Data are given on the effects of varying concentrations and pH levels of sodium o-phenylphenate solutions, duration of dip, rinsing, and the addition of hexamine. The occurrence of rind injury is due to absorption of o-phenylphenol and the effectiveness on wastage control depends upon the levels of both sodium o-phenylphenate and o-phenylphenol. The degree of rind injury depends primarily upon the concentration of o-phenylphenol in the solution, which can be controlled by pH adjustment. Accordingly, an explanation of the role of hexamine is given. Sodium p-phenylphenate control of mould wastage is superior to control by borax-boric acid."

("The Phytotoxic and Fungicidal Effects of Sodium o-phenylphenate in Controlling Green Mould Wastage in Oranges." J. K. Long and E. A. Roberts. Australian J.Agric.Res., 1958, 9, (5), 609-628.)

AUSTRALIA - NEW SOUTH WALES

Liver Fluke Control: Carbon tetrachloride is indicated as the drug of choice for control of the internal parasite. It is given in single strength, i.e. 1 c.c. carbon tetrachoride diluted with 4 c.c. liquid paraffin. If double strength is used it will also assist in clearing out large stomach worms.

For control of the snail vector, copper sulphate is generally employed, but more recently copper pentachlorophenate has been developed. Dosage rates are not stated. Care must be exercised in using copper preparations on country where chronic copper poisoning (toxaemic jaundice) occurs.

(From "Animal Health Notes" published in The Agricultural Gazette of New South Wales, Aug., 1958, 69, (8), 430).

The following pest control measures are noted:

Agricultural

Citrus Red Scale, *Aonidiella aurantii*: Spraying has largely superseded fumigation with HCN. The present method is treatment with 0.1% malathion plus 1% white oil spray.

White Louse Scale, Unaspis citri: Use of colloidal or dispersible sulphur, combined with routine Bordeaux mixture sprays, applied for fungus disease control, has been widely accepted by coastal citrus growers for control of white louse scale. This method has largely replaced winter spraying with lime-sulphur for this purpose.

Brown Scales, Saissetia oleae and Coccus hesperidum: There were heavy infestations of these scales in some coastal and inland orchards. Where parathion spraying has been adopted for the control of red scale, heavy infestations of soft brown scale frequently follow, with excessive production of honeydew and consequent sooty mould. Preliminary experiments indicated that ant control by ground application of dieldrin sprays may provide good supplementary control of brown scales.

Red Spider, Tetranychus telarius: Single applications of metasystox, aramite or aramite plus ovex, kelthane and tedion, gave very good results against spider in experiments at Orange. P.C.P.B.S. gave poor control. Chlorobenzilate gave a quick kill, but reinfestation was fairly rapid and some injury to apple foliage occurred.

Codling Moth, Cydia pomonella: Experimental fortnightly application of diazinon gave excellent control and, in addition, controlled red spider and light-brown apple moth, Tortrix postvittana. In other trials malathion at 2½ week intervals gave excellent control on pear and apple. In addition, very good control of red spider was achieved and there was little trouble from light-brown apple moth.

Red Mite, Bryobia praetiosa: Applications of lime-sulphur 1:20 plus superior oil 1/100, to which BHC miscible oil was added for woolly aphid control, gave complete mortality in eggs when applied at green tip stage on apple. Where superior oil 1/50 was combined with Bordeaux mixture 1:1:10 plus BHC miscible oil, the results were less effective.

Banana Beetle Borer, Cosmopolites sordidus: Experimental findings indicate that:

(a) Low-volume dieldrin ground sprays give results equally as good as high-volume sprays, at the general application rate of 8 to 10 oz. dieldrin per acre.

(b) Total ground sprays in dieldrin give as good control as when applied to bases of plants, and suggest the possibility of adding insecticide to routine weed-control spray.

(c) Dieldrin dust applied to plant bases gives very satisfactory results.

(d) Aldrin sprays at 1 lb. per acre are equal to dieldrin sprays in effectiveness, but diazinon at 1 lb. per acre is less satisfactory.

Veterinary

Sheep Blowfly, *Lucilia cuprina*: In a semi-field trial, in which the technique of artificial implantation of maggots represented blowfly strike, aldrin 0.05% and dieldrin 0.025% protected sheep for eighteen weeks. Diazinon 0.025% was still effective at thirty-three weeks.

Stored Products

Wheat Weevils, *Calandra oryzae and Rhizopertha dominica*: An experimental fumigation of oats stored in 2,000-bushel galvanised iron silos, at Cowra during spring, with carbon bisulphide at three pints per 1,000 cubic feet, combined with a residual spray of DDT on the outsides of the silos, provided satisfactory control of primary and secondary grain beetles. A heavy infestation of bagged wheat at Seven Hills was controlled by fumigating with methyl bromide (1½ lb. per 1,000 cubic feet) plus residual spraying with 2% methoxychlor wettable powder. Tests with maize in 5-gallon drums, gave three to four months' protection by the use of malathion dust, whilst BHC dust continued effective for six months. Phostoxin did not give a complete kill when single tablets were inserted in individual bags of maize.

(Report of the Department of Agriculture for the Year ended 30th June, 1957.)

AUSTRALIA - QUEENSLAND

Pests and Diseases: Drought caused difficulties in combatting insect pests, particularly moths and caterpillars. Without the natural checks of the more usual weather conditions pest populations were generally large and widespread, generations overlapped and infestations were experienced over longer periods. Many new locality pest records were made, and in some instances abnormal pest behaviour was exhibited. Sprays and dusts, even when applied more frequently than usual, did not always give the desired protection to crops under hot dry conditions. A few pests, such as fruit flies, which require wet conditions were not active until late summer, and then only in limited areas.

Citrus: Because of the drought many coastal orchardists were hesitant in applying normal spray programmes under dry conditions, and white wax (Ceroplastes destructor Newst.) was particularly abundant. In other districts, where only sprays against red scale (Aonidiella aurantii Mask.) were applied in the hope of controlling several pests, the results were not satisfactory. Another series of orchard trials was completed. The results again demonstrated that oil, despite some horticultural disabilities, is still basic to the successful control of scale pests on citrus. They also supported general field observations that the numerous additives and alternatives, mostly highly toxic, which are suggested from time to time are, by killing parasites, probably doing more harm than good.

Vegetables: It is stated that cabbage pests were difficult to combat. In general, difficulties in controlling pests were parallel with those of growing the crops without adequate soil moisture, and experience during the year indicates the necessity for an approach to vegetable pest control which will cover the various conditions encountered over several seasons, even with the same pest complex in a particular district. Results from screening trials against cabbage pests did not suggest an adequate insecticide control under hot dry conditions.

Peanuts: Further field trials confirmed that the mercurial seed dressings, while excellent for controlling pre-emergence rot, Rhizopus arrhizus, are of no use for the elimination of crown rot, Aspergillus niger. With the organic fungicides such as captan the position is reversed. By using a combined dust containing two-thirds organic mercurial and one-third captan it was possible to retain the advantages of each constituent and obtain high emergence figures followed by a low incidence of crown rot. The mixed seed dressing was subsequently used on a commercial scale by the Peanut Marketing Board with very good results.

Tobacco Blue Mould: In two seedbed screening trials 32 different sprays or combinations were compared. It was established that the best of the copper compounds used was home-made cuprous oxide, while the most efficient organic fungicides were zineb, chloranil and benzyl salicylate. The most interesting outcome of the screening trials was the demonstration of the synergism exhibited in several mixtures of fungicides. This will be investigated in more detail in the coming season. The four most promising fungicides were used again in a field trial employing early and late timing schedules and priming plus a late spray. The most successful treatments in preventing foliage infection were, in order of merit, benzyl salicylate, zineb, and home-made cuprous oxide. The last mentioned was best in preventing vascular infection.

The phenomenon of acquired resistance was met with once again. It is obvious from several seasons' experimental work and field observation that an early mild infection with blue mould will condition a plant so that it is less severely affected by subsequent epidemic outbreaks. This phenomenon is to be investigated in more detail in the coming season.

Banana: Field work on the control of common leaf spot, *Mycosphaerella musicola*, has been brought to a close. In the final experiment it was shown that copper oxychloride and zineb could be substituted for Bordeaux mixture without loss of efficiency. The supplements white oil and malachite green are, however, essential in all cases. Laboratory work is being directed to ascertain the particular part played by these supplements. The Bordeaux-white oil-malachite green formulation has been used on a commercial scale by a number of banana growers using various spray outfits. The control of leaf spot achieved by efficient operation is spectacular, almost complete elimination of the disease being obtained in comparison with heavy infection in unsprayed plantations in the same locality.

Pineapple: Investigations have failed to produce evidence that a fungus is responsible for isolated wilt in pineapples. Extensive root and soil isolations using various techniques have not revealed a likely causal organism and it is now assumed that a mycological factor is not involved in this particular type of wilt.

(Annual Report of the Department of Agriculture and Stock for the Year 1957-58.)

Sugar Cane

Greyback Cane Beetle, *Dermolepida albohirtum*, Waterh.: Field trials have been initiated to compare the spraying of a suspension of lindane in water on the soil with BHC dust applications. The advantages of lindane are its lower cost and lower phytotoxicity.

Frenchi Beetle, *Lepidiota frenchi* Blbk.: Field trials are being conducted in which 20% crude BHC dust has been applied at 75, 90, 105 and 120 lb/acre.

Funnel Ant, *Aphaenogaster pythia*, Forel.: Field trials with aldrin and gamma BHC either disced in with the seed of the prior legume crop at 4 lb/acre or applied in the half-open drill at 2 and 4 lb/acre did not reduce the ant populations to any observable extent. As an alternative to soil applications, insecticides are being tested in poison baits. The ants feed readily on 60% sugar solution or on a 50% dilution of table syrup, when mixed with either bran or sawdust, and with or without the addition of sodium benzoate. Diluted black molasses was not readily accepted. When insecticides in normal concentrations were added to the sugar solution, sodium arsenite, chlordane, lindane and dieldrin all gave unsatisfactory mortalities over an eight day period whereas parathion and diazinon were much more promising. Because of the superior persistence of diazinon when set out in a bait in the field, it is proposed to extend the scope of the investigations with this insecticide.

Ratoon Stunting Disease: The hot water treatment campaign is said to have given extraordinary district-wide improvement in crop production.

Bacterial Mottle: The causal agent of this disease has been isolated from several grasses, and the name Pectobacterium carotovorum var. atrosepticum suggested; it is possible that it is essentially a disease of grasses causing infection to susceptible canes when flooding occurs.

New Guinea Cane Collecting Expedition: It is reported that 206 out of a total of 262 canes have survived the 12 months quarantine in a plot on Magnetic Island. An intensive insecticide programme using dieldrin and E.605 as a spray, and Metasystox as a spray and a soil treatment, was followed in order to keep the insect population in the plot at a minimum. It did not control stem mites, Steneotarsonemus bancrofti, giant termites (Mastotermes sp.), linear bugs (Phaenacantha australica), mealybugs (Saccharicoccus sp.) or midrib miners (Cosmopteryx sp.) but known vectors of cane disease, such as aphids and leaf hoppers, were reduced to a minimum and prevented from breeding.

(58th Annual Report of the Bureau of Sugar Experiment Stations.)

Lucerne Pest Control: The following recommendations are made:

Against cutworms (Euxoa radians and Agrotis infusa) spray with DDT at ½ lb. a.i. (active ingredient) per acre; against jassids (Austroasca spp. and Austroagallia torrida spray DDT at 1 lb a.i. per acre. Lucerne leaf roller (Tortrix divulsana) is readily controlled by spraying either with DDD (TDE) at 1 lb/acre or DDD (½ lb/ac) plus white oil (1 part to 100 parts spray). Damage caused by the lucerne looper (Zermizinga indocilisaria) can be prevented by applying DDT at ½ lb a.i. per acre. Damage by Heliothis to seed crops can be prevented by spraying with DDT (1 lb/ac) just after intense moth activity or at the first sign of larval infestation. Thrips (Thrips tabaci) and plant sucking bugs are controlled with a DDT (1 lb/acre) spray.

When the lucerne seed wasp is troublesome, harvesting the crop before the late formed pods are mature will ensure good quality seed reasonably free of damage. Early cutting or grazing is recommended when red spider mites present a problem. Boom spraying is the most effective means of applying insecticides in lucerne crops. To ensure adequate penetration and coverage, the volume of spray delivered should be not less than 15 gallon per acre. Insecticides should not be applied within a week of either cutting or grazing.

(G. H. S. Hooper, Queensland Agric. J., Oct. 1958, 84, (10), 595-7.)

Cotton Pests (1): In central Queensland, a large number of insect species is associated with cotton crops in the field. Some, such as cutworms, thrips and the cotton tipworm may injure the seedlings; Heliothis larvae destroy squares and bolls; rough and pink bollworms and yellow peach moth caterpillars attack mainly the older bolls; the harlequin and stainer bugs puncture bolls; and the fifth group including loopers, leaf perforator, web spinner, jassids and aphid, injure foliage.

Chemical control measures, effective in many cases, are discussed. The degree of pest mortality is found not to be an important factor in increasing over-all yields in the better crops. Account has to be taken of plant behaviour and general field conditions.

Citrus Fruit Fly (2): Two species of major economic importance are described: Queensland fruit fly, Strumeta tryoni Frogg. Perkins fruit fly, Strumeta humeralis Perk. Symptoms of damage and contributory factors are described. DDT sprayed twice (0.2% strength), 2 weeks apart, will usually effect control.

Buffalo Fly (3): Trials indicate that back-rubbers impregnated with DDT can be used successfully for the control of buffalo fly in the coastal cattle country of north Queensland. They proved as effective as periodic spraying with DDT. Their advantage is to save mustering cattle for buffalo fly control in the wet season when that parasite is the chief source of worry. Units were placed near watering points and camps where cattle congregate in the wet season. In these situations animals used them naturally.

(1) "Control of Insects in Cotton in Central Queensland." T. Passlow, Queensland Agric. J., 1958, 84, (9), 557-560.

(2) "Fruit Fly Control in Citrus Orchards." A. W. S. May, Queensland Agric. J., 1958, 84, (9), 561-566.

(3) "Back-Rubbers to Kill Buffalo Fly." D. F. Mahoney. Queensland Agric. J., 1958, 84, (9), 511-515.)

The back-rubbers were charged with a 5% solution of DDT, first in dieselene and then in fuel oil. Fuel oil was preferred as dieselene was suspected of causing irritation to the animals. The oily solutions of DDT did not wash out with the rain and were therefore used in preference to water soluble preparations.

Fruit Flies: It is reported that all deciduous fruits, particularly stone and pome, also almond and walnut crops, are susceptible to fruit fly attack. The chief pests are:

Queensland fruit fly,	*Strumeta tryoni* Frogg.
Jarvis's fruit fly,	*Afrodacus jarvisi* Tryon.
Perkins's fruit fly,	*Strumeta humeralis* Perk.

Symptoms of damage and the factors influencing damage are noted. Harvesting as a means of avoiding fruit fly damage is considered of practical importance only for apples and figs. Success of fruit fly control depends on the prevention of egg laying by the flies during fruit development. A DDT spray programme timed to coincide with periods of fruit fly activity is recommended.

("Fruit Fly Control in Deciduous Orchards." A. W. S. May. Queensland Agric. J., Aug. 1958, 84, (8), 493-96.)

AUSTRALIA - SOUTH

Apricot-Black Heart: Black heart is caused by the *Verticillium* fungus, which is best known for being responsible for *Verticillium* wilt in tomatoes, and, to a lesser extent, in potatoes. *Verticillium* is soil-borne and gets into the tree through its roots.

The fungus has a wide range of hosts including many common garden and orchard weeds. It can survive in the soil for many years, so once a tree has died from black heart the soil should be sterilized before replanting in the same site.

Black heart in orchard trees is usually associated with either one or both of two contributing factors - waterlogged soil and the growing of more susceptible crops, especially tomatoes, between the trees.

("Black Heart of Apricots". M. B. Spurling. J. Dept. Agric. S. Australia, Sept. 1958, 62, (2).)

AUSTRALIA - TASMANIA

Southern Armyworm, Persectania ewingii Westw.: In some seasons this pest causes considerable damage to crops particularly oats, barley, peas and grass seed crops and to pastures from late October to mid-January; since extensive damage may occur within the space of a few days prompt detection is essential. P.ewingii is a nocturnal moth and advantage has been taken of its attraction to lights at night by installing light traps which help to forecast outbreaks.

DDT is effective in controlling armyworms: for spraying, the normal dosage is 4 ozs a.i./ac but in dense crops such as peas 8 oz/ac should be used to ensure that sufficient DDT penetrates to kill caterpillars feeding close to the ground. For low volume spraying equipment the most suitable formulation of DDT is the miscible oil or "pour-in" type emulsion. Spray volume is 10-15 gal/ac. For dusting 5% DDT dust applied at the rate of 8 lb/ac is recommended.

Control of Turf Pests

Corbie and Winter Corbie may be controlled by DDT spray at the rate of 1 fl. oz of 20% DDT miscible oil in 1 gal water per 60 sq. yds. or 1 fl. oz. 25% DDT miscible oil in 1½ gal water per 75 sq. yds. Dusting with 1 lb 5% DDT dust per 100 sq. yds. or 1 lb 2% DDT dust per 40 sq. yds. will give reasonable control.

Cockchafers: Pasture cockchafers may be controlled by spraying BHC at the rate of 1 fl. oz 7% BHC miscible oil in 1 gal water per 60 sq. yds. Dusting with 1 lb 1% lindane dust per 100 sq. yds. or 1 lb 2% DDT dust per 50 sq. yds. gives reasonable control. Root-feeding cockchafers are difficult to control due mainly to the problem of getting the insecticide down into the zone where the grubs are feeding. Some measure of control may be obtained by applying three fl. oz 7% BHC miscible oil in 1 gal water/60 sq. yds. and watering liberally to facilitate the penetration of the insecticide into the soil.

Earthworms can be controlled by applying 1 oz of derris dust (4% rotenone) per 2 sq.yds. and washing the dust into the soil with 1 gal water per sq.yd.

(Ministry of Agric., Entomology Div. Tasmanian J. Agric., 1958, 29, (3), 250-253 and 271-272.)

Orchard Mites (1): Materials such as ovotran or chlor-paracide can be used with good effect because of the control they exercise over the summer egg stage of the mites. Organic phosphates such as malathion, parathion and diazinon are effective against the adult mites, but have only relatively low persistence and, therefore, two sprays at an interval of ten to fourteen days are required. The new material Trithion is effective against the adult mite and has a much greater degree of residual effect than other organic phosphates. Other new materials showing good results against Bryobia mites are Meta-systox, Kelthane and Tedion.

Winter sprays are not effective against red spiders, but organic phosphates as listed above may be used as summer sprays. Various other materials which can be used against the red spider include Aramite, Kelthane, and Tedion.

Beet - Downy Mildew (2): The mildew causes rosetting of the inner leaves which become curled and flattened, pale in colour, and covered with the buff-grey spore masses of the fungus. Seed crops are also attacked. The disease is caused by the parasitic fungus Peronospora schachtii Fuckel. Methods of transmission are by (a) infected seed, (b) contaminated soil and plant refuse, (c) infected seed plants, and (d) air currents through the field. Suggested control measures include (a) use of clean seed, (b) rotation, (c) destruction of diseased material, and (d) spraying with 4:4:40 Bordeaux mixture at 7 to 10 day intervals.

Codling Moth (3): The control of codling moth has not been a matter for great concern amongst apple and pear growers for over twelve years. The very effective insecticide DDT has performed satisfactorily and on most orchards it is still effective. There have been instances in the last two years, however, on four properties in Victoria and on a considerably wider scale in South Australia, that some strains of codling moth have developed resistance to DDT.

(1) "Seasonal Advice for Orchardists." G. W. Gayford. J. Agric., 1958, 56, Pt. 10, 663-665.)

(2) "Downy Mildew of Beet in Victoria." D. E. Harrison, J. Agric., 1958, 56, Pt. 10, 675-677.)

(3) "Seasonal Advice for Orchardists." G. W. Gayford, J. Agric., Victoria, 1958, 56, Pt. 9, 581-583.

Tests in Victoria and South Australia have shown that organic phosphate sprays may be used as alternatives to DDT, and will give good results, but a greater number of sprays is required because of their poorer residual effect.

As DDT continues to give satisfactory control of codling moth in Victorian orchards and as more information is needed on the effectiveness of organic phosphates on the control of light-brown apple moth, it is not intended to suggest that DDT should be replaced as the main weapon in the attack on codling moth. However, it is proposed to recommend that, following the first spray after petal fall, which should be a combination DDT, 0.1% plus TDE 0.05% or lead arsenate for codling moth control, organic phosphate sprays should be applied instead of the usual DDT plus TDE.

Halo Blight (Pseudomonas medicaginis var. phaseolicola (1) is the most serious seed-borne disease of beans in Victoria. Halo blight is a bacterial disease and is recognised by the halo of yellow tissue surrounding a small, brown necrotic spot on the leaves. It not only reduces the yield of the bean crop, but the "grease spot" pod lesions of the disease spoil the pods for sale at market.

Spread of this disease is controlled by spraying with Bordeaux mixture 6:8:100 at fortnightly intervals from the two-leaf stage.

Other seed-borne diseases which are less important in Victoria are American bacterial blight, Xanthomonas phaseoli and anthracnose, Colletotrichum lindemuthianum, a fungal disease.

AUSTRALIA - WESTERN

Webworm, Talis pedionoma Mayr.) (2): The popular name webworm has been applied to a small caterpillar whose depredations in ploughed-in wheat crops have concerned farmers in this State for many years. The first record of the insect as a pest was made by Newman (1927) under the scientific name of Sclerobia tritialis Wlk. and it has been referred to as such in some subsequent Departmental publications. Recent investigations, however, suggest that either more than one species of insect is covered by the term webworm or that the true webworm is a Crambid moth known as Talis pedionoma Mayr. Preventive measures involve clean fallowing, early sowing and initial ploughing and possibly extra cultivation between ploughing and planting. Chemical control with DDT is recommended using 6-8 oz actual DDT per acre.

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(1) "French Bean Seed Certification." R. O. Kefford. J. Agric. Victoria, 1958, 56, Pt. 9, 608-611.

(2) "The Webworm." C. F. H. Jenkins. J. Agric. Western Australia, 1958, 7, (4), 415-421.

Low volume sprays of various types and aircraft have been effectively used to spray webworm affected crops. The amount of liquid applied per acre will depend upon the type of equipment used, but rates of 2 gallons and even lower have proved satisfactory with aircraft while many ground units operate efficiently at from 5-10 gal per acre. The performance of any spray outfit should be carefully tested before treatment is actually commenced in order that accurate calculations can be made in connection with the dilution of the concentrates. As a guide to the speed of operations it should be noted that a 30 ft boom will cover about 20 ac per hr at 5 miles per hr.

Once a crop has suffered severe webworm injury spray treatments may not ensure satisfactory recovery despite the destruction of caterpillars. For best results therefore sprays should be applied at the first sign of webworm activity. Spray or dust applications on pasture at top dressing time will give good control of webworm, but so far there is no evidence that pre-sowing applications of insecticide will protect a crop.

For pasture protection DDT-superphosphate mixture applied at the rate of 90 lb of 0.25% dust per acre during the late summer have given good control and 2% DDT applied at the same rate has given protection for 2 years.

Pink Rot - Potatoes (1): During May, losses of potato tubers from pink rot were reported on several properties in the Dardanup, Harvey and Benger districts.

In addition to a description of its symptoms and spread the following methods of prevention are noted:

1. As the disease is soil-borne, a four-year rotation should be practised on contaminated land.

(1) "Pink Rot of Potatoes." S. C. Chambers. J. Agric. Western Australia, 1958, 7, (4), 405-406.

2. Use only clean seed and destroy diseased plants and tubers, preferably by burning so as to prevent soil contamination.

3. Where necessary improve the drainage of land which has borne a diseased crop.

Vermin Control - Bonuses (1): While animal and bird pest control authorities and experts throughout the world condemn bonus systems, bonuses not only receive tremendous support from the graziers and farmers directly affected by the pests, but they are still being widely backed and used by local and government authorities. In Australia today bonuses are being paid in all States (possibly excluding Tasmania) and in some cases are regarded by the primary producers and authorities as a major control measure.

CANADA

Veterinary: Chorioptic mange in cattle continued to be a regulatory problem. It occurred on 22 premises, with 98 animals, infected as follows: Nova Scotia, 1, Ontario, 17, and Manitoba, 4 premises.

All infected cattle were treated under official supervision. In dealing with these outbreaks of cattle mange, the entire herds were quarantined and all animals on the premises, totalling 933, were officially treated and the premises and contact matter cleansed and disinfected. The chorioptic mange mite appears to be responsible for practically all cases. As a precautionary measure, all overseas importations of cattle are officially treated twice for mange before being discharged from quarantine. No cases of sarcoptic or psoroptic mange were reported.

(Canada Department of Agriculture. Report of the Veterinary Director General for the Year ended March 31, 1957.)

CANADA - ALBERTA

Coyote Control: The following approved poisons were supplied, free of charge, for coyote control in the settled areas of the province.

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(1) "Bonuses for Vermin Control." A. R. Tomlinson. J. Agric. Western Australia, 1958, 7, (4), 465-469.

(a) Cyanide in the form of cyanide guns or "coyote getters".

(b) Strychnine - as special pellets, each containing 2 grains of strychnine.

(c) Sodium fluoroacetate (Compound 1080) for use in preparing meat baits.

Rodent Control: Against Norway rats, Warfarin and Pival poison baits, plus carbon monoxide, were the main control measures used.

(Annual Report of the Department of Agriculture of the Province of Alberta for the year 1957.)

CANADA - QUEBEC

Forestry: For the third consecutive year, aerial spraying of forests against the spruce budworm, Choristoneura fumiferana, was carried out in 1956. The insecticide used was commercial DDT dissolved in a mineral oil at the rate of 1 lb/American gal, which formed a solution of 12½% by weight. It was applied at the rate of ½ gal/ac to 688 sq. miles of forest. A preliminary appraisal has shown that the percentage of destroyed larvae was satisfactory and consequently the major part of the year's foliage was spared. The overall effect of spraying cannot be determined for several years.

(Report of the Minister of Lands and Forests of the Province of Quebec for the year ending 31st March, 1957.)

CEYLON

Agricultural Pests:

The following insect pest control measures are noted:

Paddy Bug, Leptocorisa varicornis: Insecticidal trials showed that gamma BHC 1.3% or 0.65% dusts were the most effective when applied at the rate of 20 lb per acre.

Paddy Stem Fly, Atherigona sp.: In a trial against a heavy infestation of Atherigona the order of efficacy of the insecticides tested was: Ekatin-parathion (0.003% a.i.), gusathion (0.0039% a.i.), dipterex (0.006% a.i.)

Paddy Pentatomid Bug, Scutinophora lurida: Chlorinated hydrocarbon and organophosphorus insecticides were tested in acetone solutions by topical application on the abdomen of the pentatomid bug. The toxicity of the insecticides in descending order was as follows: gamma BHC, endrin, dieldrin, parathion, dipterex, chlorthion, diazinon, gusathion, malathion, DDT. Aestivating bugs proved highly resistant to insecticides.

Complete control was achieved with the following: dipterex at 1 fl. oz in $7\frac{1}{2}$ gal, malathion and diazinon at 1 fl. oz in 5 gal, gusathion at 1 fl. oz in 4 gal, chlorthion at 1 fl. oz in $7\frac{1}{2}$ gal, and dieldrin at 1 fl. oz in 2 gal. Dipterex, chlorthion and malathion were in the form of 50% emulsifiable concentrates and gusathion and dieldrin were 20% emulsifiable concentrates.

Leptoglossus membranaceus: Insecticidal trials of this pest on cucurbits were conducted with BHC, aldrin, endrin, dieldrin and DDT. Only BHC, at 1.3% and 3%, were satisfactory, as only these gave 95-100% control of both adults and nymphs.

Bean-Fly, Agromyza sp. A 24-hours immersion of seeds in low concentrations of chlorinated hydrocarbons gave satisfactory germination and effective fly control. Immersion for 24 hours in 1 in 500-1000 solutions of aldrin, dieldrin and endrin 20% emulsion concentrates gave fly infections of only 1-12% compared with 80% in controls.

Aphis laburnii: In tests on heavy infestations of Aphis laburnii on cowpea at Danowita, the following organophosphorus insecticides gave 100% control at the dilutions mentioned: parathion 47.5% emulsion concentrate at 3 cc per gal water, malathion 50% emulsion concentrate at 4 cc per gal water, diazinon 60% emulsion concentrate at 2 cc per gal water, when sprayed at the rate of about 50 gal of spray per acre.

Grain Storage Moth: Trials were made as follows:

A. Grain treated and put into untreated bags

Pyrenone dust at 1.6 and 3.2 oz/bushel
BHC 0.65% dust at 2 and 4 oz/bushel
Malathion 0.5% dust at 22.5 and 45 oz/bushel

B. Bag treatment

Bags containing untreated grains were treated every month on the surfaces with one of the following insecticidal solutions:

Malathion 50% at 1 and 2 fl. oz/gal
Gamma BHC emulsion concentrate at 1 and 2 fl.oz/gal
Pyrenone emulsion concentrate at 2 and 5 fl.oz/gal.

C. Grain treated as in A and sprayed as in B

After 6 months the following observations were made:

1. Of the "grain treatment only", malathion at both concentrations gave the lowest intensity of pest attack.

2. Of the "grain and bag treatments", all the bags showed very low rates of pest infestation.

3. The "bag treatment alone" did not appear to give as good results as in the case of "grain and bag treatment". The malathion treatment at high concentration gave the best results.

4. The untreated checks were heavily attacked.

5. The germination of grain was 87-99% 6 months after treatment.

(Administration Report of the Director of Agriculture for 1957. Part IV - Education, Science and Art (C).)

Tea

Lygus Bug, *Lygus viridanus*: Effective control has been given by 2 or 3 applications, at weekly or fortnightly intervals, of a 50% DDT dispersible powder diluted in the proportion of 1 lb per 25-30 gal water and applied at the rate of 100 gal/ac.

Tea Tortrix, *Homona coffearia*: Outbreaks of this caterpillar were traced to the temporary absence of the parasite, *Macrocentrus homonae*. A severe outbreak is also reported due to the application of aldrin dust to bushes, instead of the soil, for the control of subterranean termites.

Shot-hole Borer, Xyleborus fornicatus: Laboratory observations have shown that the lower parts of tea bushes are not only the places where some females make galleries but also the places through which many bettles pass. Field experiments with Dieldrex Extra and Chlordox, sprayed on the lower parts of the bushes only, gave promising results. Further trials on this method of control are being carried out.

Nematode Control: In fumigation trials Nemagon applied at 8-10 gal/ac reduced the eelworm population by about 90% for some months, but after 7 months the population gradually increased. Experiments have been made with Marigolds, Tagetes sp. which have been effective in controlling eelworm in trials in Holland. Preliminary observations on pot experiments showed a reduction of 115 to 2 eelworms, Meloidogyne sp. per sample, 4 months after the sowing of Marigolds.

(The Tea Research Institute of Ceylon, Annual Report for the Year 1957. Bull. No. 39.)

Blister Blight Control (1): The relative efficiency of 12 fungicides was compared with the standard 50% cuprous oxide treatment. It was found that formulations of copper-oxides and oxy-chlorides of varying copper content as well as colloidal copper and copper-carbonate gave efficient control at 60 oz or 8 oz/ac. Also spraying of these fungicides at 3 oz or 4 oz/ac throughout a moderately severe monsoon afforded satisfactory protection in most instances (on tea in plucking). The coated dispersible powder formulation containing 16% copper and also three organic fungicides applied at 8 oz were significantly less efficient than the standard 50% cuprous oxide at 6 oz/ac. Bordeaux mixture at 8 oz gave protection in measure with its copper content, equivalent to 4 oz of a 50% copper fungicide.

The total yields of the sprayed plots over the period concerned varied only insignificantly in most cases, irrespective of the fungicides applied or their rate of application. The loss in crop on the unprotected plots averaged 16% over the monsoonal period in comparison with adequately protected areas. The advantage of a practical system for forecasting the severity of blister blight infestation was discussed with regard to reducing the costs of spraying without serious risks.

(1) "Blister Blight Control in 1957 with Respect to Fungicidal Formulation, Application Rates and Yield." T. Visser, N. Shanmuganathan and J. V. Sabanayagam. Tea Quarterly, 1958, 29, Pt. 1, 9-20.

Mite Control (1): It is reported that the use of dust for control appears to merit consideration when there is an insufficiency of water for spraying, and when the tea is of such a size and density to preclude the successful manipulation of sprayers and the application of the spray. Regarding spraying, no treatment so far given has provided any degree of immunity beyond about 10 months. It now appears inevita inevitable that certain fields will be subject to annual attack and that a routine spraying programme, as for blister blight control, is necessary. It is, therefore, proposed to initiate control measures from about mid-March, completing the programme by mid-May at the latest. During this period, the blister blight spraying programme is progressively reduced, and with a significant number of sprayers and adequate labour available no difficulty is anticipated in completing the programme.

Although no direct relation between copper spraying for blister blight control and the recent increase of mites has been found, some connection is thought to exist. A microscopic examination of village tea where no copper has ever been applied on the boundary of the estate, has revealed no scarlet mites, though purple and yellow mites were seen. The adjoining area of estate tea which is regularly sprayed with copper, is heavily infested with scarlet mite.

Tea, Control of Pests in Nurseries

Pest	Control Measures
Tea Aphids	Spray Nicotox "20" - 1 oz in 2 gal water. One application.
Thrips	Spray 50% DDT - 1 lb in 25 gal water. One to two weekly applications.
Scale Insects	Spray Nicotox "20" - 1 oz in 1½ gal water. Three weekly applications.
Yellow and Purple Mites	Spray Thiovit or Spersul - 1 lb in 25 gal water. Two weekly applications.
Scarlet Mite and Red Spider	Spray Thiovit or Spersul - 1 lb in 25 gal water. Three weekly applications.
White Grubs and Cut Worms	Pour Intox "8" or Chlordox - 6 pints per sq. yd., dilution 1:2000. One application.

("Selection and Vegetative Propagation of Tea." T. Visser and F. H. Kehl. Tea Research Institute of Ceylon. Pamphlet No. 3. Oct. 1958.)

(1) "Further Observations on Mite Attacks in Haputale During 1957." C. N. J. Mulrenan. Tea Quarterly, 1958, 29, Pt. 1, 60-3.

Rubber: In trials against leaf disease caused by *Phytophthora palmivora* copper-based fungicides proved to be most effective. These contained 4-6% copper as cuprous oxide or copper oxychloride and were applied at 8-10 lb/ac at 5-day intervals. Some organo-metallic and organic fungicides gave fairly promising results.
(Annual Report of the Rubber Research Institute, 1957.)

GHANA

Snail Control (Bilharziasis): "Whilst onchorcerciasis is a most serious hazard of the fishermen in flowing waters, the "occupational disease" of the fishermen in still and sluggish waters is Bilharziasis. One or other of the snail hosts of *Bilharzia* is present in most such waters of the Northern Region and their control is a matter of importance to fishery development. Biological control with a fish agent offers the only prospect of success with safety to the fishery, for chemical methods tend to be damaging to both animal and vegetable life and are costly. In 1953 a breeding stock of a Cichlid fish, *Serranochromis macrocephala*, was brought by air to Ghana from the Belgian Congo. This fish had been given a high reputation as a snail eater. Unfortunately, perhaps owing to the change of seasons, this fish has not bred satisfactorily, and it has not been possible to put it to the test. However a native Cichlid, *Hemichromis bimaculatus*, has shown itself to be a determined fancier of the *Bilharzia* snails and it has been stocked widely in the North-west and elsewhere. Results have varied from an apparently total disappearance of the snails to no significant effect at all. As might be expected the most disappointing results have come from heavily turbid waters, and where the presence of large numbers of other small predators, notably the cousin *H.fasciatus*, have restricted populations and individual size. The most striking results have been with *Physopsis* snails, and with *Limnaea* the host of liver fluke in cattle. But results have sometimes been excellen with *Biomphalaria* snails particularly where they alone are present.

Simulium Fly Control (Onchocerciasis): Onchocerciasis is the scourge of the river fishermen and indeed of all whose business brings them to the riverside. In the dry season the *Simulium* fly host of the disease is at its most menacing in the North-west on the Black Volta, whilst in the rains the tributary streams are invaded. At this time the fly will range far from its breeding points. Breeding controls, generally using DDT solutions, have been widely attempted elsewhere. This work has not always been successful, or safe to the fish populations of the treated streams, the margin between an effective dose for the *Simulium* larvae and a safe one for the fish being very narrow.

Work in Canada had shown that DDT solutions when used in highly turbid water had a much greater effective range against the Simulium larvae than in clear water, and other insect populations and fish were little affected. The inference was that the DDT became absorbed on suspended inorganic matter such as clay, in which form it was selective to the filter feeding Simulium larvae. Experiments aimed at producing a material in which DDT was deliberately associated with clay were begun by the Department at Lawra in 1954, and have resulted in a product which is harmless to fish at very high concentrations, whilst very low concentrations achieve a range against Simulium larvae much greater than that of conventional DDT solutions. A solution of DDT in kerosene is heated in company with a sludge of fine clay using soap as an emulsificant. The resulting product is then completely dried. It is mixed with water to form a heavy suspension before use.

This material was tested on the Kamba River in 1955 and 1957 and on the Black Volta in 1955, 1956 and 1958. These tests showed that the effective performance of the material in terms of range is dictated principally by time, and that the time limit is approximately three days. A mean flow of nearly 1½ m.p.h. is therefore required if a range of 100 miles is to be expected. The range is not materially increased by raising the DDT concentration above 0.04 parts per million which is the rate normally used for 30 minute applications.

The Black Volta was treated from Ouassa bridge in French Haute Volta from the 16th December, 1957 to the 28th January, 1958, 11 applications being made into a flow falling from 2,600 cusec. to 1,000 cusec. Flyboys were stationed at the junction of the Kamba and the Black Volta, some 32 miles downriver from Ouassa and at Mombelo near Lawra, about 40 miles from Ouassa. They worked from 8 a.m. to 12 a.m. and from 3 p.m. to 5.30 p.m. each day, capturing and counting the Simulium flies that attempted to bite them. The number that made the attempt, per boy per day, was taken as a measure of the Simulium infestation at that point. The Kamba River had then ceased to flow but three miles above Mombelo on the French side a large tributary, the Boughari-ba, enters, and this was still flowing strongly and breeding flies. In spite of a complete absence of breeding at both points, it can be noted that the Kamba mouth fly catch fell more quickly and more decisively than that at Mombelo. This effect has been noted on previous occasions and is doubtless due to Mombelo catches including a number of Boughari-ba flies, which one would expect to move downriver in declining waters to be blown by the fierce downstream Harmattan wind. It is also interesting to note that a quite massive recovery was made at Kamba mouth very soon after dosing was concluded, whilst at Mombelo fly activity has remained slight. A range of not less than 70 miles was achieved by this series of treatments, but at 100 miles the destruction of larvae did not appear to exceed 75%. At this distance the effect steadily declined with the reduction of flow. As on former occasions there was no disturbance to fish.

The 1957 tests on the Kamba river, an important tributary of the Volta, consisted of eight doses made in a period of 31 days, from 7th October to 8th November, into a flow declining from 538 cusec. to 41 cusec. The applications were made some 24 miles from the junction of this river with the Black Volta and were effective throughout its length. Several small and inaccessible tributaries were still breeding Simulium flies when treatment commenced, and this dosing series once again emphasised the impossibility of quickly achieving a major reduction in fly numbers where only part of a catchment is treated.

Simulium breeding controls, which had been instituted at Tumu and Ga in 1956, were continued throughout the period of flow in 1957. Both these townships are situated very close to dam spillways, eminently suitable for Simulium breeding during the rains. The controls were maintained by unsupervised labour, a fixed amount of the DDT and clay material being used at each dose regardless of flow. No damage to fish was noted, although, in periods of low flow, concentrations will have reached several parts per million. Controls were also initiated at several other spillways in Lawra District. The simplicity with which these spillway controls are conducted and their low cost is very striking. The effort required to bring relief to the considerable populations concerned is minute, particularly when compared to the costly task of protecting the thinly spread populations of the main river valleys. Whilst there must be doubt as to whether a worthwhile degree of Simulium control on the main rivers is either possible or practicable, there can be no such doubts regarding control of spillways and other localised breeding points."

(Report of the Fisheries Department 1957.)

INDIA

Coffee: The pests of coffee and their control have been comprehensively reviewed by Dr. P. Somasekhar, Entomologist, Research Department, Coffee Board, Balehonnur in a special issue of the Indian Coffee Monthly Bulletin.

(See June 1958, Indian Coffee, 22, (6), 220-246.)

MALAYA

Rice: Field investigations have shown that: the main carry-over of stem-borers from one season to the next is on volunteer (self-sown) padi; there is steady and rapid build-up of borers through the season; vigorously growing padi is preferred to poor padi; the numbers of tillers bored varies with districts; most damage is caused at flowering. Experiments are being conducted to confirm whether stem-borers can be controlled by spraying and to estimate yield losses due to borer attack. Dieldrin and DDT where padi-field fish are of economic importance are being used.

Extensive attacks of army worm, Spodoptera mauritia, have been reported from several areas and Nymphula depunctalis has been of widespread occurrence at Trengganu. The black padi bug, Scotinophora coarctata is now widespread over the whole country but can be controlled by DDT and BHC dusts. Against the green padi bug, Leptocorisa acuta, fogging with oil-miscible insecticidal formulations in diesoline is being used.

Rats are being controlled mainly by zinc phosphide baiting; over 66,000 kills have resulted from about 50% of the bait laid. Attempts to control crabs in padi fields using aldrin and dieldrin killed many fish and water snakes. Though no dead crabs were observed, the treatment acted as a deterrent and there was no further damage to the padi crops.

Oil Palm: Dusting with calcium arsenate proved ineffective against bagworm, Cremastopsyche pendula Joannis, and experiments have been laid down to compare BHC dust with DDT and dieldrin fogs. BHC dusting was ineffective against the leaf-eating caterpillar, Orgyia turbata and DDT spraying was recommended for trial. A severe attack of the rhinoceros beetle, Oryctes rhinoceros L. occurred on young oil palms planted on old rubber land. Control is being achieved by burning the rubber and hand collection of grubs and adults.

Coconuts: The incidence of Oryctes rhinoceros appears to be increasing. This is explained by the fact that the beetle has been found to breed extensively in felled rubber and rubber replanting is now being conducted on an extensive scale. Control of the slug caterpillar, Chalcoscelis albiguttata, which caused damage in the coastal area of Selangor, was achieved by spraying with dieldrin (1.5% a.i.).

Pineapples: The field trial in connection with mealy-bug wilt to discover whether plants could be kept free of mealy-bugs by fumigation of planting material and periodic spraying with insecticide has been continued. The mealy-bug population in the treated plots was lower at first and growth of the plants in the treated plots was greener and more vigorous, However, this difference has now, about a year and a half after planting, disappeared. Failure to prevent mealy-bug invasion of the treated plots is thought to be due to too-infrequent spraying and rapid inactivation of the insecticide (dieldrin) used on the peat soil.

Cacao: A comparison of foliage sprays against Apogonia spp. showed that 0.4% lead arsenate solution and 25% DDT miscible liquid at 0.08% gave better control than 0.3% dieldrin or 50% DDT wettable powder at 0.2%. Helopeltis theobromae has been effectively controlled by fogging with DDT or dieldrin.

Tea: It is reported that DDT spraying was ineffective against leaf-rolling caterpillars, Ernarmonia leucostoma Meyr. Blister blight, Exobasidium vexans was effectively controlled by copper oxide fungicides.

Sweet Potato: Soil treatment with 0.1% aldrin solution was recommended against Cylas formicarius.

(Annual Report of the Department of Agriculture for the Year 1956.)

NEW ZEALAND

Horticulture

Pip Fruits: It is reported that of the newer therapeutants, captan has come into general use for controlling black spot, Venturia inaequalis, and ripe spot. The application of 0.01% phenyl mercury chloride just before leaf fall significantly reduced black spot infection of Delicious apples in the following season. The increased use of captan and carbamate fungicides to control black spot has resulted in greater prevalence of Powdery Mildew, Podosphaera leucotricha, in Hawke's Bay. In some areas karathane was used more extensively for controlling Powdery Mildew. In trials on Jonathan this material and sulfane were more effective than sulphurs and resulted in better foliage condition and later leaf fall.

The trend towards the replacement of winter oil by intermediate oils, applied at green tip, continued. Chlorobenzide was a widely used acaricide and tests of materials based on amiton-oxalate and methyl-demeton gave promising results as did kelthane. Diazinon proved very effective against red mite at Alexandra and also completely controlled woolly aphis. In a Christchurch trial intermediate oil at green tip with aramite in summer, and chlorocide at pink also with summer aramite, were the best of several treatments tested.

Stone Fruits: In some districts a build-up of red mite necessitated additional sprays. For the control of brown rot, spray trials have given some good results: a test with calcium cyanamide treatment to prevent the spring discharge of ascospores, which is responsible for blossom infection, was inconclusive, though an orchard trial was promising. Capsid bug damage appeared to be reduced by pre-blossom sprays of DDT.

Berry Fruits: red spider mite, Tetranychus telarius was the most troublesome pest and control proved difficult on strawberries. Fruit rot was controlled to some extent by captan, thiram and zineb. Soil dressings of DDT and aldrin were applied to counter the attacks of black beetle, Heteronychus sanctae-helenae.

Citrus Fruits: Dieldrin is being used with success against thrips and malathion in combination with summer oil has shown promise for control of scale insects. Some use is being made of chlorobenzide and chlorfenson sprays to control red mite, Paratetranychus citri and of captan as a substitute for Bordeaux to control brown rot, Phytophthora citrophthora.

Veterinary

Sheep: The surface application of aldrin and dieldrin either as dusts or fine sprays was effective in controlling both lice and keds. With a 3% dieldrin dust the initial kill was slow, but it was complete and gave protection from reinfestation with lice for over 6 months.

Fly Control in Dairies: Preliminary trials have been carried out to test the effectiveness of a fly repellent based on butoxypolypropylene glycol against Stomoxys calcitrans. The repellent gave protection equal to 50% reduction of flies for 96 hours but it would be too costly for continuous control.

Toxicity to Bees

Toxaphene was sprayed and dusted from the air over 12 acres of white clover pasture at the maximum rate of 5 lb of actual toxaphene per acre. Strobane was sprayed from the air over 8 acres of white clover pasture at the maximum rate of 5 lb of actual strobane per acre. All applications were made in the early morning before bees began to fly. The toxaphene applications had no adverse effect on an experimental apiary and the strobane caused only negligible losses. It is considered that both insecticides can be used safely on white clover pasture. These insecticides can now be used to discover if they will control the clover case bearer moth which causes extensive damage to and losses of clover seed. They should also prove of value in controlling insects infesting crops.

(Report of the Department of Agriculture for the Year ended 31st March, 1958.)

Forestry: It is reported that the white-fringed beetle, Graphonotus leucoloma which proved troublesome at Woodhill nursery, was finally controlled with dieldrin. Biological control of wood wasp, Sirex noctilio by release of Ibalia leucospoides has continued and the parasite is now fully established in several forests. An improved rearing technique now being developed should increase supplies in the future.

Regarding damage by vertebrates it is stated that control operations have in the past dealt with principally the animal in relation to its specific environment, but it is apparent from many recent reports that combinations of animals particularly of deer, opossum, and goats, are now causing the greatest damage. For example, the opossum, by killing trees, opens up bare glades in the forest from which the deer can intensify their browsing damage. Future operations must include the study of all animals present in any area.

(Annual Report of the Director of Forestry, 1st April 1957 to 31st March, 1958.)

SOUTH AFRICA

Soil Steriliser for Eelworm Control: The tobacco fields in the Union have been attacked by eelworm to such an extent that its control has become a major problem. Present methods of soil sterilisation are ineffective and the costs are very high. After examination of the problem and existing methods experimental models were built to determine the basic requirements.

Particle Size Distribution in Liquid Sprays: The following topics are noted:

1. Particle size distribution by various types of impactor and other samplers followed by microscopic counting using phase contrast equipment.
2. Determination of statistical parameters and distribution laws.

3. Different types of spray nozzles and their behaviour, with particular reference to production of fine sprays.
4. Electrostatic size analysis methods for dusts and sprays.
5. High speed photographic investigation of sprays and fumes.

Entomology: Among the studies noted are:

1. Bionomics and control of *Epilachna canina* on potatoes.
2. Bionomics and control of *Syagrus rufigrons* (cotton pest).
3. Biological control of soft brown scale, *Coccus hesperidum*.
4. Behaviour of brown locust, *Locustana pardalina* in its solitary phase.
5. Effect of organic insecticide residues on honey bees.
6. Influence of insecticides on eggs of the brown locust.
7. Olfactory and gustatory reactions of the adult house fly.
8. Test methods and test insects for the biological assaying of insecticides.
9. A comparative study of X-ray and other methods in determining insect infestation and damage to plant seeds.

(Register of Current Scientific Research at South African Universities 1957.)

Black Spot in Pineapple (1): Experiments were carried out on the black spot disease of pineapples in the field and laboratory, to ascertain the pathogenicity of the fungi *Penicillium funiculosum* and *Fusarium moniliforme* and to determine the host-fungus relationship, i.e. conditions governing fungal entry into, and invasion of the fruit.

Inoculations with these two fungi produced black spot in all cases where the skin of the floral cavity had been broken, irrespective of the age or variety of the fruit.

Thielaviopsis paradoxa and *Phoma* sp. inoculated in floral cavities caused an orange discoloration of the tissues, quite distinct from the typical brown-black colour of black spot lesions. This indicates that though these fungi are frequently isolated in conjunction with the *Penicillium* and *Fusarium* from black spot lesions, they are not essential for the production of disease symptoms.

Two types of black spot, "wet" and "dry" spot, can be distinguished. Wet spot is produced under humid conditions, particularly in ripe, juicy fruits; dry spot is more prevalent in young and less juicy fruits.

(1) "Some Aspects of Black Spot in Pineapple". C. Edmonstone-Sammons. South African J. Agric.Sci., June 1958, 1, (2), 111-120.

The presence of cracks and breaks in the floral cavity, through which causal fungi can enter is of prime importance in the incidence of the disease. These cracks may presumably be caused by insects or may be the result of mechanical rupture of the tissues.

Residual toxicity of parathion spray in Quelea control (1):

Various methods of eradicating the weaver bird, *Quelea quelea lathami*, commonly known as the red-billed finch were tested on a large scale.

The most effective were found to be (a) blowing up of large roosting swarms and breeding colonies with liquid fuel and dynamite, (b) nocturnal aerial spraying of such swarms and breeding colonies with solutions of parathion of 25 to 30 per cent concentration. Both methods effected a kill of 95 per cent or higher, but the first had the disadvantage of being slow, cumbersome and very expensive. This method has now been replaced entirely by the second, which, having the great advantage of mobility, is rapid and costs only about one quarter of the dynamite-fuel method.

The disadvantage of the spraying method, however, is the high toxicity of parathion to human beings and livestock. The fact that parathion kills by both oral intake and contact makes it doubly dangerous. For this reason it was considered imperative, to investigate the length of the period during which vegetation would remain toxic to livestock after being sprayed with parathion in concentrations used for the eradication of quelea. This investigation was subsequently extended to include studies of (a) the biological effects on cattle of pasturage sprayed with parathion, (b) the effect of roasting and cooking on the parathion deposited on quelea killed by this method, (c) the toxicity of water contaminated by parathion spray and (d) sensitivity of fish to low concentration of parathion.

When planning the investigation it was realised that the rate at which the parathion residues on the vegetation decreased could be greatly influenced by seasonal weather. It was therefore decided initially to plan a series of five tests which were to take place during the five seasonal periods experienced in the areas infested by *Quelea* namely, late summer, autumn, winter, spring and early summer. All these experiments were conducted under controlled practical conditions.

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(1) "Preliminary Investigations of the Chemical and Biological Aspects of the Use of Parathion in the Eradication of *Quelea Quelea lathami*." C. Van Rooyen and D. C. Lourens. South African J. Agric. Sci., June 1958, 1, (2), 151-174.

Five tests were conducted to investigate the toxic life of parathion residues that settle on vegetation when roosting colonies of Quelea finches are sprayed from the air with solutions of this poison in light diesel oil. It was found that:-

(a) the concentrations of parathion that settled on the ground vegetation was initially high

(b) these concentrations decreased rapidly during the first week after spraying

(c) irrespective of initial concentrations, after 22 days they all tended towards a common low value completely harmless to livestock

(d) the rate of decrease is directly affected by climatic conditions experienced during the different seasons; the shortest periods taken to reach a concentration of 50 p.p.m. occurred in early and late summer and the longest in mid-winter; the rate of decrease of the parathion concentration appeared to be influenced by average seasonal temperatures

(e) rain during the experimental periods did not affect the rate of decrease of the parathion residues on the vegetation, and

(f) the benzene-soluble wax content of the vegetation appeared to influence the rate of decrease of parathion. Higher wax content appeared to reduce the rate of decrease.

An experiment was conducted in which four groups of five steers each were differentially treated. One group was muzzled, placed in a paddock of pasture and sprayed from the air with a solution of parathion in light diesel oil. After 24 hours the muzzles were removed and the steers allowed to graze. The other three groups were introduced into the sprayed paddock at different intervals after spraying.

(a) None of the animals showed symptoms of contact poisoning within 24 hours after spraying.

(b) Steers allowed to graze the contaminated pasture within 25 hours after spraying showed definite symptoms of parathion poisoning; three of the 15 steers died.

(c) The group of five steers introduced into the paddock seven days after spraying showed no ill effect in spite of relatively high concentrations of parathion on the vegetation

(d) Other tests in which cattle were dosed with parathion solutions caused death at a concentration of 200 mg. parathion per kg. bodyweight but not at 100 mg. per kg. bodyweight.

Experiments were conducted to ascertain the extent to which the water would be contaminated when spraying quelea colonies in reed patches situated in water pans and to ascertain the sensitivity of fish to the effects of parathion poisoning. It was found that:-

(a) the maximum parathion concentration found in the water at the observation points was 3 p.p.m.

(b) this concentration was not considered dangerous to livestock and probably not to human beings

(c) large numbers of barbels (Clarias mossambicus) died as a result of eating the quelea killed by the parathion spray.

Laboratory tests were conducted to determine the sensitivity of fish to the effects of parathion poisoning. It was found that a concentration of 5 p.p.m. parathion in a form miscible or emulsifiable with water was lethal. Fish were less sensitive to parathion dissolved in an oil immiscible with water.

The effect of roasting and cooking on parathion residues on Quelea which had been killed by parathion spray was determined. It was found that although the parathion was not destroyed the concentration was reduced to such an extent as to make it harmless to human beings.

Fumigated stored grain (1): The problem of surface spoilage in grain stored in untreated and undisturbed bulks is regularly encountered in South Africa and elsewhere. The spoilage results from an accumulation of moisture in the surface layers of grain. This is mainly caused by the existence within a bulk, of large temperature gradients which set up convection currents and cause a migration of moisture.

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(1) "Moisture Migration in Horizontally-Stored Bulk Maize: The Influence of Grain-Infesting Insects under South African Conditions." A. Joffe, South African J. Agric. Sci., June 1958, 1, (2), 175-93.

In view of the relatively mild climatic conditions in South Africa it was thought that severe temperature gradients and consequent surface spoilage in maize should not occur provided that heat-producing grain insects were eliminated from the grain mass. In order to test this hypothesis horizontal bulk storage experiments were conducted at four representative sites. At each site, two similar bulks of maize were stored; the one bulk was fumigated with methyl bromide and thereafter sprayed with insecticides, while the other was untreated and allowed to develop a normal insect infestation.

At two of the sites a serious insect infestation became established in the untreated maize during the first year of storage, and in the autumn, grain temperatures in the interior of the bulks increased steadily in spite of a drop in air temperature. At the beginning of winter the surface of the untreated maize had become mouldy and "caked", the grain being so wet in parts that individual kernels even sprouted. In contrast, the fumigated grain remained dry, cool and in sound condition during this time. At the remaining two test sites the insect populations in the untreated grain only became established in the second year of storage, and moisture accumulation became evident in the summer when extreme grain temperatures were recorded. Once again the fumigated maize remained in sound condition.

The results indicate that the safe storage of undisturbed, horizontally-held bulk maize is possible for prolonged period without the use of mechanical ventilation, provided that grain-infesting insects are controlled.

The conclusion is reached that some of the beneficial results obtained in other countries with the use of low-volume mechanical ventilation installations may partly be due to the inhibitory effect of the cool or dry ventilating air on the activity of insects present in the grain.

Termite Control: The replacement of sodium-arsenite grass bait by sodium fluosilicate grass bait for the control of Hodotermitid harvesters (Hodotermes and Microhodotermes) is described. In terms of acute oral toxicity sodium fluosilicate is just under eight times less toxic than sodium arsenite and is also distasteful to livestock.

The bait is prepared by adding 1 lb sodium fluosilicate to 8 gal of water and stirring during the addition of chaffed hay. The poison content of the bait approximates that produced by dipping chaff into a 1.25% hot solution of sodium fluosilicate which is impractical in the field. The wet bait is removed from the solution and thoroughly dried.

It is shown that this bait, applied during the winter months at a dosage of two muid* bags per acre, has hitherto been used with complete success to control infestations of H. mossambicus over 121,543 acres of unfenced grazing in Zululand, without a single case of cattle or sheep poisoning having been recorded.

("The Hodotermitid Harvester Termites of South Africa," W. G. H. Coaton, Science Bulletin No. 375, Department of Agriculture, 1958).

SOUTH AFRICA - NATAL

Control of Wattle Bagworm, Kotochalia junodi

Spraying experiments: (L. L. J. Ossowski). Single tree plots were treated from the ground with three different insecticides: toxaphene, endrin, and a similar chlorinated hydrocarbon WL 1650. The insecticide was dissolved in light diesel oil, toxaphene at the rate of 0.75 lb per gal of solution, and the two others at 0.67 oz per gal. The rate of application was two gal per acre. One experiment was carried out when the bagworm larvae were in their earlier instars and another when the insects were older. Mortality was assessed eleven days after spraying in the first and after fourteen days in the second experiment. The rate of "fall-off" of dead and moribund larvae was also determined.

In both experiments, no difference in the final percentage "fall-off" between the treated plots was found, though in the first experiment, the initial rate was highest in those treated with endrin. There was no significant difference in overall toxicity between the insecticides applied against larvae in their earlier instars. Endrin, however, was significantly superior to the others when used against older larvae.

Aerial spraying: In 14 spraying days between 26th October and 27th November, 2,814 acres were treated with toxaphene dissolved in light diesel oil at the rate of 0.75 lb/gal of solution. 2,060 acres were treated with 3 gal/ac and 754 acres with 2 gal/ac. Only 4% of the total area sprayed showed an unsatisfactory kill.

Biological control (Virus disease in Bagworm)

(a) Experiments, 1956: The outcome of these experiments was assessed and it was found that there was no marked difference in the

(* 1 muid = 24 gal = 3 bushels)

overall kill whether higher or lower concentrations were used. Mortality due to polyhedrosis alone, however, was somewhat lower after the use of the latter. Mortality was highest up to the second instar, and more females than males succumbed to the disease. The kill was lower in plantations in which suspensions prepared from local virus material were sprayed than where virus introduced from a distant source was used, but even where the kill was lower, mortality was still high enough to prevent serious defoliation of the trees. Virus artificially disseminated may not only cause epizootics in the treated plantations, but may spread to neighbouring blocks in the year following treatment. A full account of these experiments is contained in a paper presented to the First International Conference of Insect Pathology and Biological Control in Prague.

(b) Experiments, 1957. Over 500 acres in various parts of the wattle-growing area were sprayed by plane with virus suspensions. The experiments were designed to test the efficacy,

(i) of suspensions sprayed before and after hatching of larvae,
(ii) of suspensions of various concentrations,
(iii) of suspensions with and without adjuvants,
(iv) of virus material prepared from local and introduced stock, and
(v) of less- and highly-virulent virus strains.

From an interim assessment of the outcome, it appears that a satisfactory kill may result from applying concentrations below 1,000 polyhedra/cu. mm. The interim assessment seems also to confirm the findings of the 1956 experiments regarding the difference in mortality due to virus suspensions prepared from local and from introduced stock.

(Wattle Research Institute, University of Natal, Pietermaritzburg, South Africa, Report for 1957-58).

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BRITISH SOLOMON ISLANDS

Coconut Pests: Owing to difficulties encountered in attempting to control *Amblypelta* indirectly by encouraging beneficial ants at the expense of "nutfall species" (see "Experiments with Ants" below) attention was given to the possibility of direct control with insecticides. From the results of trials it became apparent that further information was required on the following points:-

(a) To what extent must *Amblypelta* be controlled to ensure full crops?

(b) Does the percentage of young nutfalls scarred by *Amblypelta* provide a good measure of the degree of control being achieved by a particular treatment?

(c) The results of the laboratory tests indicated a very poor residual action with DDT emulsion against *Amblypelta* on coconut tissue. This is unexpected considering the susceptibility of closely related Hemiptera to DDT.

(d) Mist spraying is the only conceivable way of applying insecticides to palm crowns on a large scale, but as the 1956 trials could only be carried out with full cover sprays no information was available on this aspect.

Items (a) and (b) are dealt with in Report No. 5.

Observations are being made on plots of palms in commercial plantations with the object of relating the amount of *Amblypelta* scarring on young fallen nuts to the crop of mature nuts produced.

Preliminary conclusions are:-

1. The relationship between degree of scarring on young nutfalls and crop of mature nuts produced is not a straightforward one, but it should still be possible to use percentage nutfalls scarred as a guide to spraying operations.

   Results during the next six months should enable a limit to be set to the percentage of nutfalls scarred which must be achieved by spraying in order to ensure full crops.

2. Some palms are able to produce satisfactory crops in the face of a higher percentage scarring rate of nutfalls than others. There is good evidence that this is due to the fact that these palms bear a larger initial number of young nuts (female) per spadix.

3. It may be possible to select a strain of palm which consistently bears a very large initial number of young nuts per spadix and which will continue to crop in spite of a normal degree of Amblypelta attack. As extensive replanting must take place in the Solomons during the next decade if copra production is to be maintained, this could be an important practical consideration.

4. Figures for observed numbers of Amblypelta, on the small observation plots, average less than one individual bug per palm. An indirect estimate of Amblypelta numbers, based on the rate of scar production indicates that actual populations are several times greater than observed populations, but probably do not normally exceed 3 or 4 individuals per palm.

Items (c) and (d) are dealt with in Report No. 6.

The poor residual action of full cover sprays of DDT has been investigated by biological and chemical means. Poor residual action of the 0.5% DDT emulsion incorporating 0.025% succinate (N) as a wetter was thought to be due to inadequate wetting but increasing the succinate concentration to 0.25% decreased the residual action. It appears that this type of emulsion consists of a mixture of emulsion particles and very small crystals. When the succinate concentration is increased the crystals form an obvious precipitate.

Results from the biological tests suggest that DDT is absorbed into coconut tissue from emulsion and crystalline formulations very rapidly after application, and rendered insecticially inactive.

A chemical investigation with DDT emulsion has confirmed that rapid absorption does in fact take place. A similar experiment has been carried out with a crystalline DDT paste formulation but results are not yet available.

A mist spray application of DDT at approximately 1 mg. per sq. cm. and a droplet size of 60-80 microns should be completely lethal to Amblypelta adults. This level of deposit should also provide a reasonable degree of immediate residual action. No information is yet available as to how quickly residual action may deteriorate with time. Further data is required concerning contact and residual action on nymphal stages.

Experiments with Ants (Report No. 6.)

Indirect control by ants consists briefly of inducing the beneficial ant species Oecophylla smaragdina and Anoploepis longipes to expand their territories and occupy palms in nutfall areas, at present tenanted by the antagonistic "nutfall ants" Iridomyrmex myrmecodiae or Pheidole megacephala. If this could be done there is no doubt at all that nutfall would be controlled in a very satisfactory manner.

In the author's opinion there is no hope of extending the areas occupied by beneficial ant species by trunk spraying unless the materials used are selective to some extent. An attempt has been made to obtain some information on this aspect with dieldrin emulsion, a material that has been used quite extensively in trunk spraying trials. Some selectivity in favour of beneficial species of ants would also be a most desirable feature of any insecticide formulation considered for direct use against Amblypelta.

Repeated trunk spraying with 0.15% dieldrin of Iridomyrmex occupied palms has failed to bring about appreciable take over by Oecophylla from adjacent palms, but such treatment prevented further expansion by Iridomyrmex.

The same treatment of Pheidole palms on the borderline of an expanding nutfall area failed to even slow down the rate of Pheidole's advance.

Increasing the rate of dieldrin to as high as 1.5% gave little improvement. This is almost certainly accounted for by the high ant populations on the ground between the palms which are unaffected by trunk treatment.

The spraying of the ground between the palms as well as the palm bases is now being tried, on the borderline of an expanding Pheidole area, in an attempt to halt its advance.

In discussion it is pointed out that although Amblypelta could be controlled by mist spraying with DDT, it would be uneconomic on present palms. Aerial spraying is regarded as impracticable and use of a helicopter is considered to be too expensive. The height, 60 feet or more of most palms necessitates very large ground operated mist blowers which are costly and difficult to transport between plantations.

However, where replanting is undertaken, there is every prospect of being able to control Amblypelta by the use of small, shoulder mounted, mist blowers, until the palms reach a height of 25-30 feet. In this connection dwarf varieties of palm may be useful.

(Entomological Research on Premature Nutfall of Coconuts in the British Solomon Islands. Entomologist's Progress Report No. 5 - The Relationship between Degree of Amblypelta Attack and Loss of Crop; Report No. 6 - Further Insecticide Experiments with Amblypelta and Ants.)

BRUNEI

Malaria Control: It is reported that all the houses (nearly 5,000) in the rural areas of the state were sprayed with DDT. Other measures include anti-mosquito drainage by open concrete and sub-soil drains, scrub clearance, larval control by oiling, and the control of adult mosquitoes by fogging with 5% DDT in kerosene and with Dieldrex 15.

(Annual Report, 1957, H.M.S.O., London).

EAST AFRICA

Tsetse Control

The section on entomology includes the following topics:

Studies on Sampling Methods for Glossina Populations: It has been shown that the numbers and pattern of catching Glossina pallidipes off cattle were very different from the numbers and pattern of catching with Morris traps. Discounting a "flyboy effect", animals of different colours attracted flies differentially. Colour of trap was important in numbers and also in the proportion of males and females, caught. Traps covered with natural colour hessian gave better catches than those covered with black hessian.

Transect Fly-Rounds: The transect fly-round consists of a path laid out on arbitrary compass bearings. The division of the transect fly-round into short sections of fixed length has given a much more accurate picture of the distribution of active tsetses both in and between various vegetation communities. The fundamental weakness of the fly-round, that it observes only such tsetses as are attracted to a moving party, is not overcome by transect-fly-rounds.

The interpretation of results is complicated by the fact that the numbers of different species caught varies with section length and also from day to day. This matter has been resolved for transect fly-rounds with short sections of arbitrary length. By means of the Poisson distribution, high or low catches have been compared with the mean catch per section and their significance calculated. This technique can determine whether an observed concentration or lack of flies is real or not, a useful advance in the interpretation of fly-round results.

Marking of *Glossina* for Location at Night: Tests with flies marked with paints which fluoresce in ultra-violet light have shown that at night *Glossina* rest on leaves; by day the resting places are boles or branches of trees.

(East Africa High Commission. East African Trypanosomiasis Research Organization Report. July 1956 - December 1957.)

Veterinary: Research on East Coast fever was continued. During a search for wild strains of *Theileria parva* certain theileria parasites have been isolated whose species status is uncertain.

A search is being made for *Theileria lawrencei* which has previously been described from South Africa. So far it has been found in buffalo and cattle from Kenya. *Rhipicephalus appendiculatus* is the vector.

(East Africa High Commission. East African Veterinary Research Organization. Annual Report 1956-57.)

Preservation of Skins and Hides: The use of solutions of arsenic compounds has long been the most popular method in East Africa for protecting air-dried hides and skins from the ravages of hide beetles. Since arsenic is so lethal a trial was laid down with dieldrin. 100 air-dried goatskins which showed no previous sign of beetle attack were divided into four lots of 25 and treated as follows:-

(a) Control - sprayed with water.

(b) Sprayed with 0.15% arsenious oxide.

(c) Sprayed with 0.25% w/v Dieldrex 15.

(d) Sprayed with 0.5% w/v Dieldrex 15.

Spraying was carried out at the rate of 1 gal/250 sq. ft (approx. 15 hides or 50 skins), both hair and flesh sides being treated.

After drying, each lot was placed in a wooden box covered with mosquito netting. Approximately 50 hide beetles and larvae were added monthly to each trial lot.

The results of the trial showed that 0.5% Dieldrex 15 gave almost complete protection. Suggestions for using Dieldrex 15 are:-

(i) Skins: spraying at the rate of 15 to 20 gal of 0.5% solution per 1,000 skins.

(ii) Hides: spraying at the rate of 20 gal of 0.5% solution per 250 hides or dipping in an 0.5% solution.

(East Africa High Commission. The East African Hides and Leather Bureau. Report for the Years 1956 and 1957.)

Ambrosia Beetle: Trials with insecticides to control *Ambrosia* beetle attack on logs in Kenya are reported in an article by S. J. Curry (East African Agric. J., October, 1958, 24, (2), 128-132.).

It is stated that for the normal expected maximum period that control of *Ambrosia* beetle should be required, i.e. from two to three months, the simplest and cheapest insecticide, which will also give effective results, is a BHC powder suspension in water.

During dry weather a 1 per cent gamma concentration at Sh. 2/30 per 100 sq. ft surface area is recommended; in wet weather a 2% concentration at Sh. 4/60 per 100 sq. ft. If logs are likely to remain in the forest for periods in excess of three months during wet weather, an oil solution of 1 per cent gamma BHC, preferably with tar additives, would be expected to give adequate protection for from four to six months in local conditions, at Sh. 5/35 per 100 sq. ft of surface.

Aluminium Phosphide: A report on tests with this chemical for bulk grain fumigation in Uganda is given by J. C. Davies (E.Afr.Agric. J. October, 1958, 24, (2), 103-105). Tablets containing aluminium phosphide and ammonium carbamate were added to infested maize contained in a welded steel bin at the rate of 10.2 tablets (about 30 gms.) per ton of maize. A very satisfactory initial kill was obtained and it is hoped to carry out further tests in the near future.

(E. African Agricultural Journal of Kenya, Tanganyika, Uganda and Zanzibar, Vol. XIV, No. 2, October, 1958).

GAMBIA

Agriculture

Groundnuts: Investigations into pre-harvest pests have now been completed. The most important pest is the species of aphid transmitting Rosette disease virus. Regulations have been introduced for compulsory insecticidal treatment of harvested groundnuts.

Public Health

Malaria: In Bathurst it seems likely that the land reclamation schemes and drainage programme of recent years have considerably altered the picture of transmission, by markedly reducing the number of mosquitoes which breed all the year round in brackish water, and increasing the proportion of mosquitoes which breed principally during the rains in fresh water.

Yellow Fever: A survey carried out in 1955 showed that in the greater part of the Protectorate there was a high level of immunity, caused by recent infection, but no clinical evidence of the disease. The area of the Kombos, near Bathurst, however, showed a low level of immunity, with no evidence of infection more recent than could be accounted for by the last known epidemic of 1934-35. It was therefore decided to carry out a programme of mass vaccination in the Kombos, to prevent an epidemic wave spreading from the inland endemic areas. This programme was carried out in 1956, with the assistance of the Federal Laboratory Service, Yaba, Nigeria, using scratch vaccination. Altogether 17,680 persons were vaccinated, estimated to be 99.7% of the population at risk. Whereas before vaccination only 29% of the population were immune, after vaccination the incidence of immunity was raised to 90% and the overall conversion-rate was 86.3%.

Schistosomiasis: The first record of intestinal schistosomiasis in the Gambia was reported from Tiborah, a village in the Western Division.

(Report for the Year 1956 and 1957, H.M.S.O.)

HONG KONG

Rodent Control: It is recognised that domestic and other conditions in many localities necessitate regular rodent control measures by trained operatives, in view of which such work is carried out free of charge in respect of both Government property and private premises. Systematic block control measures with rodenticides, followed where necessary by trapping of surviving rodents, were carried on throughout the year. The re-disinfestation system, whereby thorough disinfestation of premises is repeated a few months after completion of initial disinfestation, was also continued as a routine procedure; this is done to achieve a more lasting degree of rodent clearance. Rodenticides in frequent use included antu, red squill and warfarin, the last-named replacing the others and being taken into general use in all areas before the end of the year. A 1% warfarin master mix was used so as to give a final concentration of 0.025% warfarin in a bait base mixture containing (by weight) 90% uncooked (inferior grade) rice, 5% castor sugar, and 5% technical white oil.

Domestic Insect Pests: Diazinon at 100 mg/sq. ft (40% W.P. at 4 oz/Imp.gal) is applied weekly, or at other intervals depending on the degree of infestation, at the Colony's refuse dump to control flies, principally *Musca domestica vicina*. Diazinon (2% water dispersion) is also being used against larvae of *Culex fatigans*. Malathion is to be used in future against the cat flea, *Ctenocephalides felis felis* as there have been several failures recently with gamma BHC.

(Report on Pest Control in Hong Kong for the Year 1957-58. Reprint from Hong Kong Annual Departmental Report by the Chairman, Urban Council, and Director of Urban Services for the Financial Year 1957-58.)

KENYA

Trypanosomiasis: At Kiboko studies of *Glossina longipennis* have continued with the object of working out a practical means of selective spraying with insecticides. A trapping experiment is being designed as a check in estimation of densities and to investigate the possibility of exterminating the fly by means of a simple trap treated with insecticide and made to resemble a resting place such as a fallen log. The practical use of attractants against *G.pallidipes* on traps and along patrol paths is being investigated conjointly with the C.P.R.U. All compounds tested, except ethyl caprate, were not attractive to *pallidipes*.

An outbreak of sleeping sickness in 1948-9 in the Nyando River Basin led to eradication measures against *G.palpalis*. In 1951, vegetation fringing the northern rivers was sprayed at 14-day intervals four times with a 5% DDT solution. In 1954, the main river and its southern tributaries were sprayed using Arkotine S.D.18 as a 5% emulsion. Some reinfested areas were sprayed again in April, 1956. No flies have been caught in the sprayed area for 16 months. Costs of spraying were £42 - £68 compared with £200 per mile for hand clearing.

In the Kuja Migori Scheme, aimed at eliminating both human and animal trypanosomiasis, Dieldrex 15 was diluted with water to 1.8% dieldrin and applied by means of knapsack sprayers and portable mechanical mist-blowers to both banks of the rivers. Four successive sprayings were given at three-weekly intervals. In sections where flies still persisted after the fourth treatment a further spraying using 5% dieldrin was applied. In October three G.palpalis were caught along 314 miles of river, and from November to the end of December none was caught over the whole sprayed area. Spraying costs, including staff salaries and cutting paths, have worked out at about £60 per river mile, while the average cost of bush clearing to construct protective barriers to reinfestation has worked out at about £150 per river mile.

Experiments designed to exterminate G.palpalis from the lake-shore on the Utonga Peninsula by spraying Dieldrex 15 at 1.8% dieldrin concentration at three-weekly intervals along the edge of the water and along paths cut near the shore were conducted during the year. No G.palpalis were caught after the second spraying.

At Chausu Point on the mainland, a spraying experiment was conducted in collaboration with the Medical Department to exterminate G.palpalis from the lakeshore with four three-weekly applications of 1.8% Dieldrex over a length of six miles. The method used in this case was to spray sections 40 yards in length with unsprayed intervals of 60 yds. along a path cut through thicket and reeds on the water's edge. No flies have been caught in this area since August, 1957.

On Ulanda Point a patch of 25 acres of bush infested with G.palpalis and G.pallidipes was sprayed five times at 14-day intervals with Arkotine S.D.18 at 5% along a series of paths cut through it. Spraying was completed in July, 1956. The main focus of flies was eliminated, but an occasional fly still continued to be caught until January, 1957, when G.palpalis disappeared completely and no G.pallidipes were caught until one fly was taken in September, 1957. There have been no further catches since then.

On Sifu Island just off the mainland, a spraying experiment with Dieldrex at 1.8% with four applications at three-weekly intervals was conducted along "hippo" paths on the lake-shore to discover what effect this method would have on the G.palpalis population. No G.palpalis were caught for several months after the fourth application but one or two of these flies reappear at irregular intervals sometimes exceeding two months. Observations are continuing on this island.

Bovine Petechial Fever: Efforts were again made to discover a possible insect vector of infectious petechial fever in cattle. Species of mosquito, *Stomoxys*, *Haematopota* and *Simulium* have so far been used. Up to date no definite transmissions have been obtained.

Ticks: Arsenic, BHC and toxaphene have all been reported on numerous occasions as failing to control the blue tick, *Boophilus decoloratus*. Asuntol, whose active principle is a substituted coumarinthiophosphoric acid ester, has been tested as a cattle spray. At 0.25% it gave satisfactory protection against ticks, when applied at weekly intervals.

(Department of Veterinary Services, Annual Report 1957.)

NIGERIA - EASTERN REGION

Yams: Yam beetle and termite attacks are reported to be widespread. Trials with Gammalin and aldrin against yam beetle were encouraging. In the Onitsha and Ogoni areas the Department has commenced selling Gammalin for application on the 1958 crop. Some aldrin has also been issued to selected farmers.

Cocoa: The black pod control trial carried out at Ikom in 1956 was repeated on the same plots in 1957. Treatments were:

T1. Picking infected pods only at harvest.
T2. Removing infected pods at weekly intervals.
T3. Spraying with proprietary copper compound (Perepod) at two weekly intervals. No picking of diseased pods except at harvest.
T4. As for T3 but spraying at three weekly intervals with picking of diseased pods just prior to spraying.

The trial confirms the results of last year's trial. The combined spraying and hand-picking treatment gave the highest yield and was the only one to show a statistically significant difference from the control at the 5% level. The fortnightly spraying treatment was next highest in yield, a reversal of last year's result where the hand-picking treatment came second. The hand-picking treatment was third with the control last. The combined treatment can be safely recommended to the farmer or for estate practice.

(Agricultural Department. Annual Report 1957-58.)

Forest Protection: All charges continued to report depredations in Meliaceae plantations by the shoot borer, Hypsipyla spp. There are no areas immune from this pest but it is becoming increasingly obvious that on good soil sites the majority of the plants will grow past the danger point and also that the use of the largest possible nursery stock contributes to success. The only areas where the pest is likely to wipe out any appreciable areas is the Aningeje Plantations where the various Meliaceae were planted in pure stands: use of the various species in mixture appears to lessen the frequency and severity of attack. For the first time attacks of this pest have been reported in natural regeneration of Meliaceae in Effium Reserve. Whether this is new or merely a new observation remains to be seen.

No solution has yet been found to the problem of Eupatorium odoratum but the general opinion is that this herbaceous pest is not the serious menace it was originally considered. New plantations given a year of protective weeding rapidly grow beyond the danger point, likewise coppice shoots without any assistance. It is reported that the local farmers are now regarding it more as a blessing than an evil; its dense mass of stems and leaves form excellent mulch and present no problem to manual clearing. The local farmer has also been quick to recognise it as a soil indicator. In this connection it is interesting to record that on a visit to Ceylon in 1957, the writer spotted this weed both in a tea estate and in a forest plantation; neither the planter nor forest officer present had noticed it before.

The Iroko gall bug, Phytoloma lata, continues to be the limiting factor in Iroko nurseries. Hitherto the only known remedy has been constant picking and burning of the affected shoots. The Department of Federal Research are now experimenting with various chemical sprays such as Folidol and Dieldrex, as a method of control. The Regional attitude is that provided sufficiently large and vigorous stock are put out as transplants, they will overcome the debilitating effects of repeated attacks. Another contemplated approach as a subsidiary to the foregoing is to raise seedlings in areas at present believed to be immune from gall attack, viz., Munshi Boundary Reserve.

The fungus pest Ganoderma collosus continues its deadly work of destruction in certain areas of Gmelina arborea in Mamu Reserve and to a lesser extent in Enugu Reserve. Its effects have not been so noticeable during the past year possibly because of the unusually heavy rains during 1957.

(Forest Department. Annual Report 1957-58.)

NIGERIA - NORTHERN

Baboon Control: A colourless variety of sodium arsenite is being used with good results.

Tsetse Control: Bauchi Province. The scheme to eradicate *G.morsitans* and *G.tachinoides* between the Udubo-Zindawa Road and Bulkachuwa is well in hand. Dry season foci of *G.morsitans* - thickets and vegetation, affording protection from heat and excessive dryness - were being sprayed with a water suspension of 50% DDT wettable powder. One application only was made. On the scheme over 100 miles of river were sprayed and foci in over 60 sq. miles of bush. It was intended to spray the area south of an anti-reinvasion barrier following the Udubo-Zindawa Road, but the dry season was shorter than anticipated and conditions favouring the dispersal of tsetse were present at the end of April. The barrier was not reached because of these factors, and during the wet season 1957 there was some reinvasion of *G.morsitans* into the areas already sprayed. The start of the dry season November, 1957 revealed that tsetse dispersal was not too great, but as a safety measure spraying activities were recommended just south of the southernmost point at which *G.morsitans* were caught. Spraying is expected to be completed to the barrier during the first week of March after which time it will continue northwards towards Tarajin. Roads have already been put in north of the barrier.

Adamawa Province: Mayo Ine Clearings: Foci of *G.tachinoides* have been cleared by the Tsetse Control Unit with funds provided by the Northern Region Development Corporation during the dry season of 1957 and 1958. *G.tachinoides* is the only tsetse in the area and is found in a number of well defined foci which have been eliminated by clearing. The upper reaches of the river have been dealt with and work is progressing on the River Mbulo, a tributary. Swingfogging has also been carried out in the area.

Numan Division: Clearing has been done and is continuing of *G.tachinoides* foci along the River Gongola. Swingfogging is also being done in the area.

Zaria Province: A defoliation experiment has been started in the Shika area in the Northern Guinea Zone vegetation and, if successful, will be applied to a larger area in the future.

Investigational work has been carried out in Niger, Zaria and Benue Provinces on the ecology of G.morsitans.

(Third Annual Report of the Northern Region Development Corporation 1957/1958.)

Tsetse Control

River Gongola: A G.tachinoides focus is associated with a large heavy forest island at Dong. Paths were cut through this and the area heavily fogged with 2% BHC in diesel oil on three occasions at ten day intervals. Since the fogging not a single tsetse has been caught for a period of six months.

Shika stock farm: Clearing against G.morsitans has progressed, leaving an area of 10 acres containing experimental plots used by the Agricultural Department. Cattle were tethered in these and G.morsitans survived there until January, 1957, when they died out during the really dry weather. However, they have reappeared in this small patch of isolated woodland in August, 1957. G.morsitans therefore here can quite happily live on cattle and when the food supply in this farm is constantly available does not need upland ecotones at the margin of the drainage line or riverine vegetation for its survival in the dry season if there is enough uncleared upland. It seems capable of re-establishing itself in a small isolated area of woodland during wet season dispersal from foci 8 miles away. Here it should be mentioned that elsewhere in the N. Guinea Zone at Kontagora and at Kaduna, G.morsitans communities have developed around cattle communities that remained during the rains. There is thus a very potent reason for the almost complete evacuation of the Fulani of wooded parts of Northern Guinea Zone during the rains.

(Annual Report on the Department of Veterinary Services of the Northern Region of Nigeria, 1956-57.)

NORTH BORNEO

Malaria Control: The joint control scheme sponsored by Government, WHO and UNICEF began in July 1955. So far the Tambunan district has been sprayed with DDT, and the Tenom district with dieldrin; until recently the Keningau area was left unsprayed as a control. After

1 year's spraying, the vector mosquito, Anopheles leucosphyrus balabacencis was found to have increased its tolerance to DDT; consequently dieldrin was chosen for the expansion areas. In 1956 the island of Labuan and Beaufort district were sprayed and spraying was extended in 1957 into the remainder of the Interior Residency including Pensiangan and the border areas with Sarawak.

Recently it became clear that although malaria was substantially reduced, transmission was not entirely stopped and a single-dose drug treatment consisting of a combination of chloroquine and pyrimethamine is now administered at the time of spraying in an endeavour to stop transmission. The results of this dual campaign are encouraging and are being further investigated.

It is also reported that the residual effect of insecticide was less than had been hoped and that the efficiency of the insecticide was reduced to approximately 40% six months after spraying. It is probable that this is connected with human habits in North Borneo, as in many houses the occupants sit on the floor resting their backs against the wall, thus rubbing off part at least of the insecticide. It therefore seems probable that two annual cycles of spraying at six-monthly intervals will be required, and it is hoped that this two cycle spraying will interrupt transmission completely. Experiments are now being conducted to ascertain whether this is so or not.

(Annual Report of the Medical Department for the Year 1957)

Abaca: Studies have been made on the symptomology of "Bunchy Top" in abaca, edible bananas and wild Musa species, the pattern of spread of "Bunchy Top", aphid movements, field trials of contact insecticides, and depth of spraying experiments. Preliminary findings are:-

(i) Expression of symptoms. Abaca hemp plants show a considerable tolerance toward "Bunchy Top" virus, which becomes chronic when it attacks edible bananas.

(ii) Pattern of Spread of Bunchy Top. Initial infections are usually sporadic to begin with but when foci of infection are established further infection appears to be by contact.

(iii) Aphid Movements. Results to date indicate that the spraying methods now in use are effective in limiting contact spread of the disease but are also expensive. It is possible that further investigations may indicate that the frequency or depth of spraying can be reduced without decreasing the effectiveness of control of contact spread.

(iv) *Field Trials of Contact Insecticides.* There appear to be no obvious difference between effectiveness of the insecticide/wetter mixtures (0.0062% gamma BHC-0.025 acetone/succinate wetter and 0.5% Agrocide plus 1:1200 Comprox A wetter.)

(v) *Depth of Spraying Experiments.* On the basis of eradication figures and the pattern of incidence of disease it is concluded that there is no significant difference in the effectiveness of three mat-deep or two mat-deep spraying in the control of "Bunchy Top".

Coconuts: Outbreaks of *Setora nitens* were controlled by spraying with lead arsenate, light trapping of moths and by breeding and liberating some 6,000 tachinid parasites, *Chaetexorista javana.* An infestation of the zygaenid moth, *Artona catoxantha* was controlled by lead arsenate sprays and by the collection of caterpillars and moths. Natural braconid parasites also helped to control this pest. Dieldrin sprays were used against a light infestation of red stripe weevil, *Rhynchophorus schach.*

Coffee: BHC was used against the coffee berry borer, *Cryphalus hampei* and the coffee stem borers, *Xyleborus* spp., and *Zeuzera coffeae.*

(Annual Report of the Department of Agriculture for the Year 1957).

Timber Protection: The graveyard test laid down in 1956 was assessed. Both red seraya and keruing showed similar average attack, but red seraya was more prone to complete failure. The attack on red seraya was largely by fungus and that on keruing by termites. The two proprietary preservatives used gave satisfactory control. The test of log insecticides was completed, the common pin-hole borers being identified as *Xyleborus granulifera*, *Crossotarsus saundersi* and *Platypus* spp.

A new insecticidal spray containing benzene hexachloride (BHC) was tried out departmentally on a small scale in 1956 and gave most encouraging results. During 1957 the same spray was tried out by one of the big companies on a fairly extensive scale but the results were disappointing. They are, however, by no means conclusive and it is proposed to conduct further trials. Damage to the living tree by a longicorn beetle, *Hoplocerambix spinicornis* is severe in some areas, giving rise to a defect known locally as *lobang pusing*; the insect causing this damage is identical with the Sal borer of India. Investigation into the control of this pest continues.

(Forest Department. Annual Report 1957.)

NORTHERN RHODESIA

Trypanosomiasis: In Kalomo and in Lusaka foci of infection on farms remote from tsetse belts were set up either by the introduction of infected animals or by carried fly. Infection spread rapidly by acyclical transmission, and mass inoculation of all cattle on the infected farms was necessary to clear the trypanosome and avert the danger of further spread. Outbreaks of this nature emphasise the immense value of modern trypanocides, which enable widespread infection to be dealt with speedily and economically with the least possible interference with normal farming routine. The problem of carried fly is aggravated by the increasing use of motor transport in and through fly belts, not only on gazetted roads, which has greatly extended the area of risk. Until further progress can be made in the elimination of tsetse flies control must be based on the control of movement and the use of prophylactic drugs.

(Colonial Office - Report on Northern Rhodesia for the Year 1957, H.M.S.O.)

NYASALAND

Tick Control: It is considered that a decline in deaths from East Coast Fever is associated with improved dipping efficiency and the improvement of cattle kholas. It is reported that in Central Province dipping, which has been in operation for many years, appears to have eradicated *Boophilus* over large areas within the tick control areas. The erection of 43 prefabricated steel dipping tanks is being financed by a Colonial Development and Welfare Fund Scheme.

Poultry: An interesting case of toxicity in chicks which pecked lime-washed walls sprayed with DDT/BHC is reported.

(Department of Veterinary Services and Animal Industry, Annual Report 1957).

RHODESIA AND NYASALAND - FEDERATION

Cotton

Control of Red Bollworm, *Diparopsis castanea*

Gatooma Research Station: An assessment was made of crop production and loss, mainly due to red bollworm, in an unsprayed acre of cotton. Shedding of buds due to bollworm was 74%, and of 12 green bolls shed per plant, 56% were damaged by bollworm. Furthermore, while approximately 12 bolls per plant came to maturity and opened, six of these or 50% were damaged only by bollworm. An analysis of the seed cotton contained in all mature bolls revealed that, due to bollworm alone, 13% of the cotton was stained and 26% was completely damaged so that it was unpickable.

In an insecticide trial endrin spray applied weekly at the rate of 0.25 lb endrin in 10 gallons of water per acre gave significantly higher yields (795 lb) than control (310 lb) or duct treatments of 10-12 lb per acre of 10% DDT plus 3% gamma BHC (445 lb). Stained cotton amounted to 16% in the control plots and was 10-20% for the other treatments.

In a further trial increase of the endrin applied to 0.5 lb/ac or increase of the volume of water to 20 gal/ac did not give statistically significant differences in yield compared with the application of 0.25 lb endrin in 10 gal water/ac.

It is concluded that weekly applications of 0.25 lb endrin in 10 gal of water per acre should be started soon after the appearance of first flower buds and continued for at least eight consecutive weeks and probably a few weeks longer, other factors being favourable to crop production. Growers are being advised accordingly.

Sabi Valley Station: An insecticide trial on irrigated cotton was carried out as follows: 0.25 lb endrin per acre was applied in 15 or 45 gal of water, at 7 or 14 day intervals, while 0.125 lb endrin per acre was applied in 15 or 45 gal of water but only at 7 day interval. Also, DDT/BHC dust 12-15 lb per acre was applied at both 7 and 14 day intervals. There were also control plots which received no insecticide. In all instances a total of 10 applications was made at the 7 day interval and of 5 applications at the 14 day interval, all starting at first buds.

The main result of the experiment was that the yield of the control plots, namely 1,304 lb seed cotton per acre was significantly less than the highest yield of 2,236 lb seed cotton per acre obtained by making 10 applications of 0.25 lb endrin per acre in 15 gal water at 7 day intervals, from first buds. Reducing the amount of endrin from 0.25 lb to 0.125 lb per acre resulted in a small reduction of yield which may be justified by a reduction in the cost per acre of the insecticide.

Tsetse Control

Aerial Spraying

Kariba: The aerial spraying operations conducted at Kariba during 1955-56 were concluded at the end of October, 1956. The fly rounds were maintained throughout the year so that the subsequent behaviour of the local tsetse population might be followed. As had been anticipated the population built up rapidly after the conclusion of treatment by migration from the surrounding unsprayed areas.

Luba Valley: This valley is infested with Glossina morsitans and G.pallidipes. A survey showed that 75 sq. miles of the floor of the valley and 25 sq. miles of evergreen riverine vegetation would have to be treated. The insecticide used was a 4% solution of gamma BHC in diesoline which was introduced into the exhaust stacks of the aircraft by means of electrically driven impeller type pumps to produce an aerosol.

An Avro-Anson was used to treat the flat areas. Flying at 120 m.p.h., this gave a swathe width of 70 yds. and each engine discharged a gal of insecticide in 27.6 secs. Tiger Moth aircraft were used on the more rugged country and along the riverine fringes. Flying at 80 m.p.h. these gave a swathe width of 25 yds. and each aircraft discharged a gal of insecticide in 62.5 secs.

Weather conditions were far from ideal. Very strong north-easterly winds were common, seriously restricting the available flying time. A 21-day cycle was selected as a suitable standard for treatment. Owing to adverse weather conditions it was achieved on only one occasion, but the interval between any two successive applications was always less than the critical period indicated by the sum of the duration of the female pupa and the prelarviposition period, except for any flies emerging after the fifth cycle. In other words, a female larva deposited immediately before an application of insecticide could mature, become adult and mate, but would encounter an application of insecticide before dropping its first larva. The treatment was sustained for 135 days, which was long enough to cover the pupal period of all pupae deposited before spraying began and even any from females that had survived the first application. The droplet size of the aerosol was maintained at a mass median diameter of 48 to 59 microns, for all aircraft, and the 50% number at 18 to 29 microns.

The full effect of the operations cannot be assessed until at least a complete season has elapsed. However, the indications are encouraging.

Fly rounds set out within the sprayed area show that the tsetse population has suffered a severe set-back. The introduction of a planned settlement based on a pattern recommended by the entomologist could lead to the permanent exclusion of tsetse from this area.

(Report of the Secretary to the Federal Ministry of Agriculture for the Year ended 30th September, 1957.)

SIERRA LEONE

Malaria Control: It is reported that the home-made "Freetown Emulsion" used for larviciding has been abandoned, as it has been shown that it is both more costly and probably less efficient than an emulsion obtained by the dilution of a proprietary brand of emulsion concentrate. A DDT emulsion prepared from proprietary concentrates is now being used.

An investigation of the susceptibility of Anopheles gambiae to BHC has given evidence of some resistance. It is intended to replace BHC with DDT for residual spraying in November, 1958.

(Half-Yearly Report - Wet Season, April, to September, 1958, Medical Department (Entomological Laboratory.)

TANGANYIKA

Tsetse Control: The results and progress of surveys and reclamation are given for the various Provinces. Near Tanga various arboricides were tried out against Cassia siamea which throws out copious bushy regeneration when it is cut down. Trials with high concentrations of 2,4-D and 2,4,5-T in various dilutents sprayed on to the stumps were made, but the results were unsuccessful. Sodium arsenite, however, successfully killed the stumps. Mangroves were treated successfully with 2,4-D and 2,4,5-T in diesel oil.

(Annual Report of the Tsetse Survey and Reclamation Department, 1957.)

Elephant Control: The present method of dealing with raiding elephant consists of shooting one or two animals in the hopes that the rest of the herd will leave the area. Sometimes this is effective, but only for a short period, and no permanent alleviation results. Raiding is commonly done by bulls and for this reason bulls are shot on control. But the movement of bulls is governed by the seasonal movements of female herds and if a bull is shot, the female herd remains and, with it, other attendant males who will continue to raid until the female herd moves off.

It has been found that by shooting a female out of a herd in the vicinity of cultivation, the herd will move away and the raiding bulls will follow. This has been proved in practice in the Southern Province. But it may well be that when the herd settles down again it will find itself close to another settled area and raiding will commence there. In the Southern Province there is a large uninhabited area to the north forming part of the Selous Game Reserve. The Game Ranger conceived the idea that if he could direct the movement of a herd after shooting the first female - possibly by shooting more females - he might be able to drive a herd through the intervening bush and cultivation into the game reserve and keep it there. He put this into practice in Tunduru District and succeeded in moving about 150 elephants from residual bush areas adjacent to cultivation to the Selous reserve, a distance of fifty miles, at the expense of ten elephants. It is hoped that this method of elephant control can be extended in 1958 since it appears to offer a more permanent solution than the method hitherto used.

(Annual Report of the Game Department 1957.)

Cashew: A survey of pests has shown that two species of *Helopeltis* are the most important. A dusting trial on seven months old cashew has shown that *Helopeltis* can have a devastating effect on young trees in a plantation and that some control will be necessary from the beginning.

(Tanganyika Agricultural Corporation, Report and Accounts for 1956-1957.)

Coffee: For the control of White Stem Borer, *Anthores leuconotus*, coffee in the lower areas of the Station was again sprayed with dieldrin over the bottom 18 inches of stem in March and again in November. The area was further extended in the latter spraying as some borers were found in hitherto untreated experiments. The original borer-infested areas of the Station have been treated with dieldrin regularly twice a year for the past three years and are now apparently free of this pest.

(Coffee Research and Experimental Station, Lyamungu, Moshi. Report for the Season 1956-57.)

Rice: Although rice suffers little attack from insect pests and diseases, significant losses of grain occur from birds. One of the control measures adopted is spraying with parathion. Where both bearded and unbearded varieties of rice are grown, the birds prefer to attack the latter varieties.

Rats and game also cause much crop damage. It is stated that the prior study of the subject of damage by birds and game before a new farm is established is advisable.

(Report to the Government of Tanganyika on Rice Production, F.A.O., Report No. 919. Rome, 1958.)

TRINIDAD

Malaria Control: In Trinidad residual spraying was carried out with DDT and dieldrin; in Tobago practically all the houses were sprayed in 1957 with DDT wettable powder but sporadic breeding of A.aquasalis still occurs. In the Cumoto, Fishing Pond and Sangre areas spraying of host plants of A.bellator with copper sulphate and their manual removal wherever necessary, was carried out.

In Sangre Grande A.bellator breeds in bromeliads infesting immortelle trees used for shading cocoa. In 1945-46, copper sulphate was applied by a high powered sprayer capable of sending a jet of 0.5% solution up to a height of about 90-100 ft, to bromeliads in 700 acres of cocoa. A check in 1957 has shown bromeliads have reinfested this area and A.bellator is again breeding there.

In Fishing Pond where A.aquasalis was the main vector DDT was applied residually in 1950, 1951, 1953 and 1955. In February 1957 although the aqasalis population was down to a minimum due to drying up of the lagoons, malaria transmission continued. Attention was now focused on A.bellator which previously had been regarded as of no importance as bromeliads were scarce in this area. Captures showed that both species were present. Accordingly copper sulphate spraying of bromeliads was carried out and dieldrin was applied residually. In addition as many people as possible were treated with camoquin and pyrimethamine. A survey in April 1958 revealed that transmission was still taking place. Since residual spraying could hardly be changed and complete destruction of every bromeliad is a difficult proposition it is felt that the solution to the problem lies in increased chemotherapy.

Aedes aegypti Control: It is reported that breeding in tree holes and in eaves gutters was increasing in the early part of the year. A decision was made to use dieldrin residually with perifocal methods as a secondary measure. After a pilot scheme in Valencia in May 1957, dieldrin was used in the second half of the year in the suburbs of Port-of-Spain and the whole of Central and North-East Trinidad. Spraying was not confined to wall surfaces, but was applied to any possible resting places such as undersurfaces of tables, chairs, inside cupboards and to outside wall surfaces near drums, cisterns and water containers. The outsides of these containers were also treated. Perifocal teams carried out larviciding with BHC. At the end of the year Aedes aegypti had vanished from the treated area.

Resistance of Bed Bugs: Resistance of bed bugs to DDT is reported from Port-of-Spain where DDT was first used in 1943. Tests were made with BHC and dieldrin; the latter gave 100% mortality in 15 minutes. Dieldrin was used in one hospital in April 1957 and a year later a check showed the complete absence of bed bugs.

(Annual Report of the Malaria Division, Health Department, 1957.)

UGANDA

Veterinary Entomology

Biting Fly Research: Laboratory and field studies on the bionomics and economic significance of biting flies other than tsetse were continued. Intensive breeding grounds were found in cattle yards and to a certain extent in adjacent banana gardens; very few immature stages have been found in grazing lands. In the laboratory, attempts to transmit T.congolense from rat to rat by Stomoxys bites proved negative, but it was noted that each fly consumed about three times its own weight of blood.

Tick Control: Departmental policy in respect of the control of tick-borne diseases continued to be directed towards improving calf management and to bringing about a reduction of tick infestation by means of spraying techniques and, in the case of small herds in the intensive farming areas, by the application of tick grease.

(Annual Report of the Department of Veterinary Services and Animal Industry for the Year ended 31st December, 1957.)

Forest Pests: It is reported that in the high forest the main cause of animal damage was elephants; 71 were shot. As an alternative to shooting experiments have started to test the effectiveness of electric fencing. In plantation areas where the main animal pests are buck, duiker, dik-dik, baboons and rats, the routine control measures are trapping, poisoning and low pruning.

Termites continued to cause serious losses in plantations; some protection has been obtained by the use of dieldrin and BHC. In

Buganda, termites seem to be very troublesome in very young plantations when trees are below 15 ft high. A new method which is proving successful is the removal of all ant hills and their queens 3-4 months before planting is commenced. Removal of the queens causes the wandering termites to have no basing point and they eventually die.

(Annual Report of the Forest Department for the Year ended 31st December, 1957.)

ZANZIBAR

Malaria: A WHO Malaria Survey Team carried out susceptibility tests on *Anopheles gambiae* to ascertain if dieldrin resistant strains were present. The results were negative and dieldrin was chosen for the residual spraying campaign to be undertaken in 1958.

In view of the unexplained increase in the fly population in the Nandi district of Kenya following the residual spraying of huts with dieldrin, a fly assessment was conducted in Zanzibar under the direction of the Malaria Institute at Amani. As a result of this, it will be possible in due course to study what effects the spraying in Zanzibar may have on the local fly population.

Schistosomiasis: A case of intestinal schistosomiasis in a patient, who had never been out of the island, is reported. This is the first record of *Schistosoma mansoni* occurring in the Protectorate and though a thorough search was made in the swamp near the village from which the patient came, no specimens of *Biomphalaria* could be found. Snails of this species had, however, been previously reported from the island.

(Health Department, Annual Report 1957.)

Citrus: Withertip disease of limes is to be investigated by a mycologist from the Colonial Pool. The investigation will be partly financed by a Colonial Development and Welfare Act grant.

Stored Products: In 1956 *Trogoderma granarium* was found in Zanzibar and legal and practical measures were taken in an attempt to eradicate and prevent re-entry of the insect. It had originally been found in cowpeas imported from Burma. In 1957 it was found in Pemba in cowpeas which were probably a remnant from the original importation. It had apparently not spread in Pemba, and the infestation was eradicated.

Legislation enacted in 1956 requires that all food grains, pulses and similar materials to be imported from certain areas of Australasia, Asia and Central Africa should be fumigated in the country of origin, prior to export. Provision was also made for the compulsory fumigation of any infested produce on arrival in Zanzibar. This legislation was strictly enforced. Subsequently it became clear that produce arriving from Burma was invariably heavily infested with Trogoderma, even though it carried a certificate of fumigation, and re-fumigation was therefore necessary on arrival. To relieve merchants from paying for produce to be fumigated twice, Burma was removed from the schedule of territories from which a fumigation certificate is required, and all produce from Burma is now only fumigated on arrival in Zanzibar. In order to satisfy mainland import regulations, and as an internal control measure, used gunny bags and articles wrapped in such material destined for Tanganyika or Kenya were fumigated before shipment. Some 4,000 bales of used gunnies were so treated. Fumigation in each case consisted of exposure to methyl bromide at a minimum concentration of 3 lb per 1,000 cu.ft. for a period of 24 or more hours.

Where a godown is found to be infested with Trogoderma, all the produce in the godown is removed to where it can be fumigated. The godown is then cleared of rubbish, which is burnt, and the godown is sprayed with malathion. The bags of all produce later stored in the godown, and the floor of the godown, are dusted with a powder containing 5% of lindane. Merchants are also encouraged to mix 0.04% lindane powder with produce specially susceptible to insect attack, e.g. cowpeas. The treatment adopted appears to be very effective for of 17 godowns originally found infested and sprayed with malathion, Trogoderma was later found with great difficulty in three only.

(Annual Report of the Department of Agriculture, 1957.)

Coconut Pests: The 100 acre experiment at Kididu has now been in progress for two years and the effectiveness of insecticidal treatment as determined by the yields obtained can now be assessed. (The maturation period of the coconut fruit is approximately 10-14 months.)

Examination of records kept for the past 20 years show that yields in the control and experimental areas averaged from a maximum of 36.5 nuts/palm/annum to a minimum of 24.3. The figures for 1956-7 were 46.3 and 48.9 for experimental and control areas respectively. Although the experimental area yield was lower than that of the control area, both areas had higher yields than in previous years. This is most probably due to the application of insecticide, for although no insecticide was applied to the control, there is no doubt it benefited very considerably from the proximity of the experimental area. During 1957/58 the experimental area showed further increases, an overall average of 56.8 nuts/palm/annum, the control showed a decrease to 40.2, but even this figure is higher than any previous averages.

The two areas had different numbers of palms, but on the basis of 5,000 palms in each area, then in terms of nuts per acre the experimental area yielded 2,840 and the control 2,100, i.e. an increase of 740 nuts per acre. If allowance is made for control area being a slightly better area and yielding 2.6 more nuts per palm in 1956-7 then the total increase would have been 870 nuts per acre.

A large amount of data has been collected and this will take some time to analyse, but already certain important observations have come to light. The experimental area can be divided into three areas (these were originally separate plantations in the past). These are: one third where palms are regularly spaced 10 x 10 metres apart - this area shows an increase of more than double the yield; one third planted 30 x 25 ft apart - this area has only given an increase of 25% in yield; the remaining third is planted anyhow and at a density of 60 to 70 palms an acre - this area shows a slight decrease in yield, although the decrease is not as great as the control. This would indicate that in spite of P.wayi it was already bearing its maximum yields and removal of P.wayi was of no benefit.

Insecticidal applications have not only increased the yields of nuts, but also the quality of the nuts obtained and their copra content. The nuts from the experimental area have yielded 10% more copra per nut than the control, so even if no extra nuts had been obtained, there would be a 10% gain in quality. The value of the extra nuts obtained is 102,620 times the average price of unhusked nuts at 110/- per thousand or £564 and the value of the extra copra £176, a total of £738. The type of insecticidal treatment that has been applied was laid down by the co-ordinating committee and was not intended to be economical. The year's treatment cost in insecticide, labour, and depreciation on machines is just under £400. This cost could be reduced to £200 a year and remain as effective if not more effective. The profit on the year's experiment is £338, but could probably have been £538 if economical spraying was attempted.

Applications of 10 DRDK have been carried out at three monthly intervals. These applications have gradually become less effective and investigation of the cause shows that this has been due to loss of power in the tractor, due to overloading. The tractor has now been overhauled and restored to its original power, and the last insecticidal application in September, following three failures, appears to be fully successful in reducing *P.wayi* to a very low level.

Although *Oecophylla* sp. decreased in number, they decreased more in the control than the experiment, and now are showing an increase in the experimental area but not in the control. This work was discontinued in July this year. The experiment has demonstrated to date that economical control can be achieved from the ground.

Since winds are frequently light or absent at night, and *P.wayi* come into the open on the spadices, it might well be that spraying at night is more effective and economical than spraying by day. With a more powerful diesel tractor and built-in spraying machine, costs in fuel and labour could be reduced by speedier application. A more concentrated DDT preparation would also reduce time, labour and insecticidal costs. Larger areas would probably reduce the re-invasion rate and therefore number of applications. Double applications are not necessary; there is sufficient residual effect to kill any first instar nymphs that may hatch after spray application.

(Progress Report of Coconut Pest Research for Period January 1st to September 30th, 1958. F. L. Vanderplank.)

RECENT PROMOTIONS, TRANSFERS AND APPOINTMENTS

The following list compiled from the information supplied by the Colonial Office, includes only the officers whose duties will be concerned with entomology, pest control and related fields.

October 1958

Collins, W. Agricultural Officer, Ghana.	Senior Agricultural Officer, Ghana.
Dickson, C. R. Senior Agricultural Officer, Ghana.	Principal Agricultural Officer, Ghana.
Drennan, D. H. Agricultural Officer, Tanganyika.	Assistant Director of Agriculture, Tanganyika.
Gray, J. W. T. Senior Agricultural Officer, Ghana.	Principal Agricultural Officer, Ghana.
Hammond, P. S. Principal Agricultural Officer, Ghana.	Deputy Chief Agricultural Officer, Ghana.

Miller, I. Agricultural Officer, Ghana.	Senior Agricultural Officer, Ghana.
Mulholland, R. Senior Agricultural Officer, Ghana.	Principal Agricultural Officer, Ghana.
Pitman, J. H. N. Senior Agricultural Officer, Ghana.	Principal Agricultural Officer, Ghana.
Silverlock, R. A. Agricultural Officer, Ghana.	Senior Agricultural Officer, Ghana.
Will, I. Agricultural Officer, Ghana.	Senior Agricultural Officer, Ghana.
Burdin, M. L., B.Sc., M.R.C.V.S. Senior Veterinary Research Officer, Kenya.	Chief Veterinary Research Officer, Kenya.
Hutchinson, R. A. B.Sc., M.R.C.V.S., Senior Veterinary Officer, Ghana.	Chief Veterinary Officer, Department of Animal Health, Ghana.
Johnson, R. H. B.V.Sc., M.R.C.V.S., Dip.Bact., Veterinary Education Officer, Federation of Nigeria.	Principal Veterinary Research Officer, Federation of Nigeria.
Pullon, I.B., M.R.C.V.S., Veterinary Officer, Tanganyika.	Assistant Director of Veterinary Services, Tanganyika.
Scott, D. J. P., M.R.C.V.S. Veterinary Officer, Tanganyika.	Senior Veterinary Officer, Tanganyika.
Turton, J. D., B.Sc., M.R.C.V.S., D.T.V.M. Senior Veterinary Officer, Ghana.	Principal Veterinary Officer, Animal Health Department, Ghana.
Blandy, R. V.	Agricultural Officer, Kenya. (first appointment)
Marks, T. G.	Agricultural Officer, Sierra Leone. (first appointment)
Roche, J.	Agricultural Officer, Sierra Leone. (first appointment)

Ross, G. K.	Assistant Conservator of Forests, Sierra Leone. (first appointment)
Craigie, Miss E. C.	Scientific Officer (E.A.T.R.O.), Uganda, E.A.H.C. (first appointment)
Gray, A. R., B.A.	T/Scientific Officer, W.A.I.T.R. Veterinary Research, Northern Region, Nigeria. (first appointment)
Innes, J. F., M.R.C.V.S.	Veterinary Officer, Tanganyika. (first appointment)
Thomsen, F. S., Veterinary Surgeon (Denmark)	Veterinary Officer, Northern Region, Nigeria. (first appointment)

November 1958

Irving, H., Senior Specialist Officer, Northern Nigeria.	Principal Research Officer, Northern Nigeria.
Paul, H. Agricultural Chemist, British Guiana.	Assistant Director of Agriculture (Research), British Guiana.
Hughes, J. F. Forest Utilisation Officer, Tanganyika.	Conservator of Forests, Uganda.
Swire, P. W., M.R.C.V.S., Senior Veterinary Officer, Northern Region, Nigeria.	Principal Veterinary Officer, Northern Region, Nigeria.
Taylor, A., M.R.C.V.S. Provincial Veterinary Officer, Uganda.	Senior Veterinary Officer, Uganda.
Collier, F. W.	Soil Surveyor Agricultural Officer, Kenya. (first appointment)
Van-Schoonneveldt, J. C.	Development Officer, (Rubber), Agricultural Department, Western Region, Nigeria. (first appointment)
Kettle, Dr. D. S., B.Sc., M.Sc., D.Sc.	Entomologist, Jamaica. (first appointment)

Addison, J. S.	Deputy Conservator of Forests, Trinidad. (first appointment)
Mitchell, W. I.	Assistant Conservator of Forests, Trinidad. (first appointment)
Chandhuri, S. K.	Arrowroot Research Officer, St. Vincent. (first appointment)
Anthony, J. E., M.R.C.V.S.	Veterinary Officer, Western Region, Nigeria. (first appointment)
Cunningham, M.P., M.R.C.V.S.	Veterinary Research Officer, E.A.T.R.O., East Africa High Commission. (first appointment)

December 1958

Hutcheson, I. S. Director of Agriculture, Bechuanaland	Assistant Director of Agriculture, Northern Rhodesia.
Parry, M. S. Silviculturist, Tanganyika.	Conservator of Forests, Tanganyika.
Wheelan, J. H. Senior Assistant Conservator of Forests, Ghana.	Conservator of Forests, Ghana.
Glover, P. E., D.Sc., M.I.Biol. Assistant Director (Zoology), Kenya.	Chief Zoologist, Veterinary Department, Kenya.
Kelly, D. L., M.R.C.V.S., D.V.S.M., Senior Veterinary Officer, Bechuanaland.	Veterinary Officer, Tanganyika.
Anderson, G. D.	Chemist, Agricultural Department, Tanganyika. (first appointment)
Hoare, B. G.	Agricultural Officer, Gambia. (first appointment)
Jefferson, J. H. K.	Principal Agricultural Officer, Northern Region, Nigeria. (first appointment)

Dunn, E.	Head of Entomology Department, West African Cacao Research Institute, Ghana. (first appointment)
Marsh, D. E. M.	Assistant Conservator of Forests, Eastern Region, Nigeria. (first appointment)
Scott, T. M.	Assistant Conservator of Forests, Northern Region, Nigeria. (first appointment)
Coutts, M. P.	Research Officer, Department of Forest Research, Federation of Nigeria. (first appointment)
Woodall, J. P., B.A.	Scientific Officer (Virologist), E.A.V.R.I., East Africa High Commission. (first appointment)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

DENMARK

Housefly Control

Gauze Strips: The increase of resistance to organo-phosphorus compounds was creating new problems in fly control in Denmark and had to be taken into consideration when recommendations for fly control in 1956 were to be made. Bayer 21/199 as a 20% wettable powder (Resitox) was dropped and diazinon as 10% wettable powder (Gesarol M) was only recommended with reservation. The use of parathion-impregnated gauze strips was once again the main method for fly control, and in order to compensate in part for the increase of parathion tolerance in the flies, the content of parathion on the strips was increased from 2.8 g to 4.0 g per m^2 of gauze. Moreover two applications, one in February-March and the other in June, were recommended. Gauze strips impregnated with compound 2675, a new German alkyl thiophosphate showed excellent effect compared to the usual parathion strips when tested after 20 days aeration in the laboratory, but after 82 days the effect had decreased very much and was quite unsatisfactory. Chlorthion at a dose of 5 g. per m^2 of gauze was not effective.

Residual Sprays: Compound 2675 was tested as an emulsion sprayed on wooden board. Its residual effect after 25 days on susceptible flies was comparable to diazinon, but as diazinon-resistant flies showed a marked cross-resistance to the new compound, it could not be approved for fly control until it had been tried on farms during a whole season.

In Manure: The following compounds were tested as larvicides in manure on farms: diazinon (20% emulsion), Dipterex (50% emulsion and 50% wettable powder), malathion (50% emulsion), parathion (35% emulsion) and thiourea. A comparison was made with a mixture of calcium cyanamide and superphosphate which has been recommended in Denmark for several years for control of fly larvae.

Diazinon and parathion were the most effective larvicides but these and the other organo-phosphorus compounds were not recommended because of the fear that widespread use of these compounds would accelerate the development of resistance to organo-phosphorus compounds, which appeared in flies in the summer of 1955, thus making the adulticides (particularly the parathion strips) useless.

The results with thiourea were of particular interest because its physiological mode of action was entirely different from those of the contact - insecticides used against the adult flies. In addition, at a dosage of 37.5 g per m^2 it protected the manure against reinfestation of fly larvae, However, thiourea was known to affect strongly the microflora of fungi and bacteria, and the compound could not be recommended for treatment of manure until its persistence and effect on the microbial processes in the soil had been investigated.

Resistance studies on houseflies: A survey of the resistance pattern in fly populations throughout the country has been made from samples from 100 selected farms. Resistance tests were carried out in the laboratory on collected flies (Fo) or on generations F1-F3.

Chlorinated Hydrocarbons (DDT, lindane, chlordane): Some highly resistant flies (often a few per cent only) could be found on practically every farm, and in addition a considerable part of the less resistant flies were likely to carry resistance genes in a heterozygotic condition. These results indicated that if these chlorinated hydrocarbons were used for fly control again, the effect would soon fail in consequence of a rapid building-up of resistance.

Dilan: The positive correlation between DDT-resistance and Dilan-resistance, indicating the action of resistance mechanisms other than dehydrochlorination, was confirmed.

Organo-Phosphorus Compounds

Parathion: By continuous exposure of flies to blotting-paper sprayed with 0.2% parathion in acetone (5 ml per 250 cm^2), which was the routine method used, only small differences in susceptibility, measured as the rate of knock-down were found.

As more and more cases of failing effect of parathion strips were reported during the summer, the parathion resistance was tested by topical application of 1 mm^3 acetone solutions to the mesonotum of female flies. Plotted in log-probit diagrams, the results gave steep lines from which the LD 50 could be read. They showed that on farms where alkyl phosphates had been used for 2-4 years (particularly as wall sprays), the LD 50 of the flies was 2-3 times normal and in one case 4-5 times normal, and exposure tests on fly strips indicated a corresponding increase of the time necessary for the flies to pick up a lethal dose by tarsal contact. This modest increase in tolerance, which we would not term development of parathion "resistance", might have been of some importance where the strips were old and dusty.

Bayer 21/199: Failure to control was reported after 2 months use. Laboratory tests showed that many of these flies enclosed on treated surfaces survived for more than 24 hours, while susceptible laboratory flies picked up a lethal dose in less than 1½ hours; and by topical application tests resistances to Bayer 21/199 from 20-500 times normal were found. Moreover it was shown that high resistance to Bayer 21/199 could also be induced by the use of parathion and diazinon.

Diazinon: Diazinon used as a wettable powder showed failing residual effect on many farms, and from October 1955 diazinon resistance was determined in flies from farms where diazinon had been used in 1954 and 1955. Topical application tests showed LD 50 up to 15 times normal and parallel exposures of flies on treated surfaces indicated that this modest "resistance" might explain the failing residual effect.

Insecticides Against Clothes Moths:

Strobane: Woollen cloth was sprayed with, or dipped in, 1% Strobane kerosene solution. The sprayed cloth was not mothproof after 2 months, but the dipped cloth was satisfactorily protected after 7 months, but not after 10½ months. Woollen cloth sprayed with an aerosol containing 5% Strobane (dosage 1.10 g. Strobane per 100 g. wool) was mothproof even after 10½ months storage and exposure in the Fade-O-Meter.

DDT Emulsion: To 2 litres of water 10 ml of emulsion containing 7.8% pp' DDT (= 0.039% DDT in the bath) was added. When 100 g. woollen materials (blanket and knittings) were washed for 4 minutes at 40°C., the DDT content in the wool was 0.33-0.72%, and the exhaustion of DDT from the bath was about 50%. Tests with moth larvae showed that the wool was well protected. With the double amount of DDT the exhaustion of DDT was up to about 90%.

A good protection of carpets and furniture covers was obtained by brushing with water containing 1% of the above-mentioned emulsion (= 0.078% DDT), but only the wool which was thoroughly wetted proved to be protected. Thus the method was not practical for thick woven rugs which could not be treated on the underside. The detergent with 7.8% pp' DDT was officially approved for protection of woollen goods when used at a rate of 5 ml per litre of water (0.5%) for washing and 10 ml per litre of water (1%) for cleaning.

Lindane-Impregnated Paper: Tests made with proprietary paper strips 12.5 cm x 100 cm impregnated with about 1.5 g lindane showed that this dosage was not satisfactory. It is suggested that the lindane-paper will probably work when it is sufficiently well distributed and used in tight containers such as boxes, clothes bags and chests.

(Government Pest Infestation Laboratory (Stored Products and Household Pests), Springforbi, Denmark. Annual Report 1955-56.)

SOUTH PACIFIC

Rhinoceros Beetle Control: The following measures for the control of Oryctes rhinoceros L. are noted; elimination of breeding material, use of pit and log traps, biological control and control by insecticides. Recent experiments with DDT, BHC and dieldrin have shown that under certain conditions these insecticides will kill adult beetles when they visit the crowns of the palms. In Fiji, BHC in the form of a wettable powder of 50% content containing 12% gamma isomer is mixed in the ratio of 1 part insecticide to nine parts sawdust and the mixture is packed into the bases of the young fronds. Cage experiments using this mixture indicated that 100% mortality was obtained in about 12 hours. Recent experiments carried out in Western Samoa using the same mixture as Fiji have given promising results. However, regardless of the results, this method is slow and laborious and therefore costly. Each palm must be climbed and hand treated at intervals of about three months.

During a survey in Madagascar, a promising predator (Scarites madagascariensis) of Oryctes grubs was found, and it was decided that this predator might be of use in helping to control the pest in certain environments in the South Pacific. Collections were made and three consignments of this insect were sent to Fiji and Wallis Island for liberation in the field.

("Rhinoceros Beetle Control in the South Pacific." C. P. Hoyt. S. P. C. Quarterly Bull., Oct. 1958, 8, (4), 18-20, 45.)

Coconut Disease: In 1928, an unknown disease appeared in a coconut plantation of San Miguel in the Philippines. In the course of 25 years it destroyed the whole of 250,000 coconut palms of the island and spread to Luzon, the main island in the archipelago, and affects the plantations throughout four provinces in the Bicol area.

The disease was named "cadang-cadang" - from the Bicol word "to die" - because it kills the palm and causes the lower leaves to turn brown and fall. It is known in English as "yellow mottle disease." Since 1951 the Experimental Station at Guinobatan has been investigating this disease. It is considered that the number of diseased palms in the Bicol area has increased from 1,788,000 in 1951 to 7,927,000 in 1956. Various theories have been postulated to explain this disease, including root decay, soil deficiency and a disease caused by a fungus, bacteria or nematodes attacking the leaves. Research has indicated that the disease does not always spread from one palm to another and is most probably caused by a virus. Its symptoms are very similar to those of other well-known virus diseases; the way in which the disease spreads appears to follow the pattern of infection of virus diseases carried by insects. But the proof that insects are the vectors will be difficult to establish, as there are at least a hundred species of insects living on coconut palms which may have to be studied separately. Furthermore, the disease does not appear on palms under four years old; it is therefore believed that the symptoms appear, at the earliest, during the first two years following contamination.

When the means of transmission of the disease is known it is hoped to find an immune variety from palms grown from seeds to be imported from all over the world.

("Coconut Trees in the Philippines Threatened with Total Destruction." South Pacific Commission Quarterly Bulletin, 1958, 8, (3), 22 and 29.)

SUDAN

Tsetse Control: In the Togren, Buok Agok, Apiath, Riangnhom and Agheir Dite areas fly routes were instituted in February. Along these and the roads, 158 hide screens were erected and sprayed twice weekly with DDT solution. Cow dung is laid under the screens to enhance the attraction of flies (*Glossina morsitans*) to the traps. In the first three named areas bait animals, cattle, sheep and goats, sprayed five times per week with 0.5% DDT or Gammexane, are being used successfully to reduce the numbers of tsetse.

(Annual Report for the year 1955-56, Ministry of Animal Resources, Department of Animal Production, Khartoum)

PROPRIETARY DATA

AEROLAC
Osmond and Sons Ltd., Grimsby.

This is a colourless, odourless, non-toxic, hard-drying insecticidal lacquer dispersed in a 12 oz aerosol container. It is reputed to kill, in a few hours, all insects which walk over it and to retain its insect killing properties for nine months. It may be washed without loss of insecticidal efficiency and is stated to be harmless to pests.

CADBURY BROTHERS LTD. BOURNVILLE.

This firm has published two reports by D. H. Urquhart entitled: "Prospects for Cocoa-Growing in Uganda and Zanzibar" and "Report on the Possibilities of Growing Cocoa in the Protectorate of Nyasaland."

Cocoa was previously grown in Uganda as a plantation crop and then abandoned. Suggestions are put forward for establishing a cocoa industry where the rainfall and soil are suitable. There are indications that cocoa in Uganda will be less troubled with pests and diseases than it is in most other parts of the world.

In the islands of Zanzibar and Pemba efforts have been made to establish a cocoa industry; Criollo was used but does not appear suitable. Stands of Amelonado type cocoa, however, are very healthy. The climate is stated to be favourable for growing of cocoa though the humus content of the soil would have to be restored and shade trees planted. Recommendations for the trial of various types of cocoa are given.

Regarding pests and diseases it is stated that the existing trees do not show evidence of serious attack by disease or pest. Phytophthora palmivora is present, but incidence of the fungus does not appear to be serious. Helopeltis is present, but this is one of the more easily controlled capsids. So far as present experience goes, diseases or pests do not constitute a threat to the economic growing of cocoa in the islands.

Suitability of the climate in Nyasaland for the cultivation of cocoa is demonstrated at Nkota where cocoa has been grown for some years. Shade trees used in tea gardens would also be suitable for the cocoa. The existing trees appear to be healthy although there was evidence of minor Helopeltis damage on some of the pods.

DUSTMASTER
J. W. Chafer Ltd., Milethorne Lane, Doncaster.

This is a precision dusting machine designed for mounting on the three point linkage of a Ferguson tractor. It has a weather-proof hopper, capacity 2½ cwt, and twin booms which are hinged and may be folded.

The machine is pre-set to apply 5-6 lbs Dustox (Micronised dust) per acre when the third gear of the tractor is used. A high speed shaft is driven from the power take-off of the tractor and in turn motivates a positive worm through a special ratchet reduction gear. This ratchet reduces the speed of the powder feed worm to 1/50th of the high speed shaft. The multi-blade blower is again driven by pre-stretched triple Vee belts from the power take-off drive.

The dust is driven by the blower along the booms and through the apertures. Removeable streamlined flexible inter-row down pipes can also be fitted.

The machine is treated against corrosion and all bearings are sealed and lubricated for life.

Special 600 x 36 narrow crop wheels or 600 x 44 high clearance wheels are available for fitting to the tractor.

Further details and of the range of Dustox dusts are available from the manufacturer.

KOLIBRIE H-3 HELICOPTER

Nederlandse Helicopter Industrie, Rotterdam, Holland.
U.K. Importers and Distributors: European Helicopters Limited, The Airport, Ipswich, Suffolk.

Technical Data

Power plant:	Two NHI ramjets type TJ-5	
Dimensions:	Main rotor diam.	33 ft.
	Length	13 ft. 10½ in.
	Skid track	6 ft. 3 in.
	Height	8 ft. 5 in.
	Tail rotor diam.	2 ft. 9 in.
Weight:	empty	530 lb
	pilot, fuel, equipment and payload	904 lb
	gross	1,434 lb
Tank capacity:	4 tanks each of 22 Imp. gal capacity for fuel or spraying liquid.	
Max. speed:	70 m.p.h.	
Rate of climb at 30 m.p.h.:	800 ft/min.	

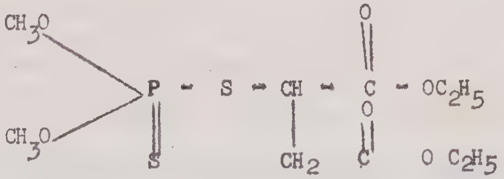
The stainless steel spray boom, braced with guy wires, is flexible and collapsible and extends beyond the rotors. The nozzles are of a swirl type, with numbered discs, which give droplet sizes from 80 microns to 200 microns. They are staggered along the length of the boom in order to give the most efficient coverage possible. The spray is held in containers on each side of the helicopter and pumped through wide diameter plastic pipes by means of a stationary engine mounted on the port side, which in turn drives a rotary type pump. It is claimed that 75 acres can be sprayed per hour.

A special trailer, the Helicar, is available, for road transportation. The helicopter may also be landed on this trailer.

Full details are available from the U.K. distributors.

MALATHION

Cyanamid.



S - 1:2 di(ethoxycarbonyl) ethyl dimethyl phosphorothiolothionate (also known as O,O dimethyl dithiophosphate of diethyl mercaptosuccinate).

Physical and Chemical Properties: Regular grade malathion is a clear brown to yellow high-boiling liquid having a mercaptanlike odour. The refractive index is 1.4987 - 1.4992 at 25°C. The specific gravity of typical product is 1.2315 at 25°C; one gallon weighs

10.25 pounds. The minimum actual malathion content of the commercial grade technical is 95%. Moisture content and metallic impurities, particularly iron, are held to a minimum. Premium grade technical malathion is a product of much improved odour characteristics. The premium material also contains a minimum of 95% actual malathion and has chemical and physical properties, except for odour characteristics, identical to those for the regular grade technical.

The pure compound boils at 156-157°C under 0.7 mm pressure with slight decomposition. It melts at 2.85°C and has a refractive index n_D^{25} of 1.4985. The vapour pressure is of the order of 0.00004 mm. of mercury at 30°C. The viscosity of malathion at 40°C is 17.57 centipoises and at 25°C, 36.78 centipoises.

Malathion is miscible with many organic solvents. Deodourised kerosene and aliphatic petroleum fractions dissolve less than 5% malathion. Its water solubility is approx. 145 p.p.m.

Stability: Malathion is stable for an indefinite period of time when stored under the proper conditions. It is stable to light but is decomposed when heated to an excessively high temperature. The product attacks iron, steel, terne plate, tin plate, lead, and copper; the last two, very seriously. Malathion and malathion liquid preparations may gel if they are placed in contact with iron, terne plate, and tin plate for a long period. Malathion may be stored without change in iron or plated iron containers provided these containers are internally coated with a satisfactory baked phenolic lacquer. Polyethylene-lined and stainless steel drums were found to be satisfactory.

There is evidence to show that high moisture in a carrier may cause the decomposition of malathion. Malathion in solution or in a finely emulsified form in an aqueous or other liquid medium is decomposed at a pH higher than 7. No instability is noted over pH range 2 to 7. Decomposition is extremely rapid at pH 12 or above. Strong acids also may be harmful.

Compatibility: Long storage stability is recorded for a wide range of pesticides in conjunction with dry formulations of malathion. Although alkaline substances react with malathion and cause its decomposition, mildly alkaline formulations containing fungicides or other pesticides can be used in conjunction with malathion in spray tank mixtures without a material decrease in the effectiveness of the insecticide. This is especially true if the mixture is used soon after it has been prepared. Soluble coppers, zineb, and so forth, can also be used.

In field tests with pesticide mixtures of malathion with other commonly used insecticides and fungicides, there was no evidence of phytotoxicity or of decreased efficiency. These tests were carried out from 1950 to 1954.

Phytotoxicity: Malathion seems to be tolerated by most plants at concentrations used for insect control, but may cause injury to certain varieties of fruits and to cucurbits.

Residues: A very considerable number of malathion residue determinations have been carried out for fruits and vegetables at various dosage levels. Malathion residues on plants are lost very rapidly after application. Temperature, sunlight, and rainfall influence the rate of breakdown of residues. Accumulated residue data on various fruit, vegetable, and forage crops indicate that on most crops malathion residues are less than 1.0 part per million ten days after the last application. On leafy vegetable crops, such as spinach and cabbage, the residues may exceed 1.0 part per million ten days after treatment because of the increased surface area and weight relationships as compared with fruit and other vegetable crops.

The method of determining malathion residues on plants is quite sensitive. The differences below 0.1 part per million are not considered significant in making comparisons.

Toxocological Data: Investigations were carried out at Hazleton Laboratories, Falls Church, Virginia. Some results are given in the accompanying table.

Uses: Malathion is recommended for agricultural use on a variety of crops, (including fruit, nut, vegetable, cereal, field, greenhouse, and ornamentals); in the public health field for fly and mosquito control and for the control of numerous household pests; and in veterinary practice against numerous ecteparasites of cattle, pigs, sheep, poultry and domestic animals. Details of specific treatments are described in brochures issued by the manufacturer. It is available in dust form and as emulsifiable liquids, wettable powders and aerosols.

Toxicological Data (Malathion)

Acute Oral

Test Animal	Formulation Used	LD50
Rats, albino male	95% technical malathion undiluted	2100 mg/kg (male)
Mice, albino	99% technical malathion undiluted	3300 mg/kg (male)
Dairy calves less than 3 weeks of age	95% technical malathion undiluted	80 mg/kg (male)
Dairy cows	95% technical malathion undiluted	560 mg/kg (female)

Single Application (Eye)

Test Animal	Procedure	Symptoms
Rabbits, albino	0.05 ml undiluted malathion 95% technical was instilled into the conjunctival sac of the left eye of each of 3 albino rabbits.	Slight, immediate irritation consisting of mild conjunctivitis, slight edema of the lids and injection of the sclera. Symptoms subsided completely within 24 hrs.

Acute Vapour Toxicity

7 Rats 13 Mice	Single exposure of air saturated with malathion vapour	Principal symptoms were excessive preening, depression and laboured respiration.

Chronic Feeding: Rats can tolerate malathion continuously in the diet at relatively high concentrations (up to 5000 p.p.m.) with slight or no outward effect on survival, food intake, or growth. At 500 p.p.m. inhibition of the enzyme in red blood cells is marked after two years, but not in the plasma or brain tissue.

MERCURIC CHLORANILATE
Fisher Scientific Company, 633, Greenwich Street, N.Y. 14 N.Y.

This reagent is a stable, dark green powder, specifically designed for the rapid, sensitive determination of chloride. On adding mercuric chloranilate to a solution of chloride, buffered to pH.4.0, acid chloranilate ion is liberated in direct proportion to the chloride ion present and is estimated colorimetrically. Concentrations of chloride down to 0.2 p.p.m. in the visible region, 0.05 p.p.m. in the ultraviolet, are detectable by this method.which is claimed to be accurate to approximately 1%.

VAPAM
Murphy Chemical Co. Ltd.

This product was developed in the United States by the Stauffer Chemical Co., who own the trade-mark "Vapam", and is covered by British Patent 789,690 and is sold in the United Kingdom by the Murphy Chemical Co. Ltd. It consists of a 32.7% w/w aqueous solution of anhydrous sodium N-methyl dithiocarbamate. This substance is quite stable in strong aqueous solutions but dilute solutions in water decompose fairly rapidly, more especially in the soil, the main initial product of decomposition being methyl isothiocyanate CH_3NCS. While sodium methyl dithiocarbamate is relatively inactive biologically, methyl isothiocyanate is extremely active against fungi, nematodes and growing plants. Moreover as it has appreciable vapour pressure it is both capable of permeating the soil and of being released from it when its sterilising action has been completed. On the other hand as it is only slightly soluble and only decomposed slowly in water it is possible to confine methyl isothiocyanate in the soil by surface flooding. Vapam has the additional advantage of being without any significant hazard as it has an acute oral LD50 for rats of 820 mg/kg. Accordingly the British Ministry of Agriculture, Fisheries and Food has recommended that the active ingredient need not be included in the Agriculture (Poisonous Substances) Regulations and that no consumer hazard will arise from its use as a soil fumigant prior to the planting out of edible crops.

In the United Kingdom, Vapam at present is only recommended as a soil treatment in glasshouses before planting at the rate of 110 gal per acre or 1 pint to 50 sq. ft. At this rate it has been found to be effective against the spores and mycelium of soil fungi such as species of *Verticillium*, *Fusarium*, *Didymella*, *Rhizoctonia*, *Phytophthora* and *Pythium*. It has also given a good control of potato root and root-knot eelworms. Vapam is also an effective non-selective, total weedkiller at the above rates. On account of this it is necessary to leave a period of several weeks to elapse after treatment before planting up, especially with sensitive crops like lettuce, to allow for the complete decomposition and release of Vapam and the derived methyl isothiocyanate.

Vapam has been used extensively in the United States for the control of eelworm and fungi in a number of field crops, and for the destruction of weeds before sowing lawns, golfing greens, etc. These uses are also being developed in the United Kingdom.

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Ecology - T. Burnett.
Biological Control - D. A. Chant.
Fruit Insects - G. G. Dustan.
Toxicology and Physiology - H. Martin.
Field Crop and Garden Insects - L. A. Miller
Medical and Veterinary Entomology - D. G. Peterson.
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ANNUAL REPORT 1954.

These reports contain the reports of Divisions, Sections and the Experiment Station, which hitherto have been given restricted circulation. Reports for 1955 and 1956 are in press.

LOCUST AND OTHER INSECT CONTROL IN TECHNICAL COOPERATION PROGRAMS IN THE NEAR EAST, SOUTH ASIA AND AFRICA, 1951-57.
A report of the Regional Insect Control Project.
U.S. Dept. Agric. Misc. Publ. No. 770. Aug. 1958. pp.147.

The accomplishments of the Regional Insect Control Project are recorded from 13 countries. Tables give data of important demonstrations of insect control. A preliminary list of the insects and mites of economic importance is also included.

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S. May and G. Plaza.

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Palais des Nations, Geneva. Sept. 1958. pp.34.

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pp.264.

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THE CARTOGRAPHY AND VECTORS OF DISEASE.
Bukavu-Lwiro 1957. CCTA/CSA Publ. No. 29. pp.70.

The recommendation was made that an atlas of both vector and disease distribution should be prepared for the important vector-borne disease of Africa.

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Tel Aviv, Israel, 1958. pp.604.

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Lourenco Marques 1958. pp.84. illus.

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INSTITUT POUR LA RECHERCHE SCIENTIFIQUE EN AFRIQUE CENTRALE (I.R.S.A.C.)

The report is divided into three parts: Administration, 2. Reviews, 3. Summaries of Scientific Papers.

LA RESERVE NATURELLE INTEGRALE DU MONT NIMBA. FASCICULE IV.
Memoires de l'Institut Francais d'Afrique Noire No. 53. pp.357. Ifan - Dakar 1958.

REPORT ON A SHORT VISIT TO THE KIVU ARABICA COFFEE AREA OF THE BELGIAN CONGO.
PART II.
D. J. McCrae, J. B. D. Robinson and J. A. N. Wallis. Coffee Board of Kenya
Monthly Bull. Oct. 1958, 23, 273 et seq.

ABSTRACTS

COLONIAL PESTICIDES RESEARCH UNIT, PORTON.
HALF-YEARLY PROGRESS REPORT, 1st APRIL-30th SEPTEMBER, 1958.

CPRU/Porton/Report No. 157.

Residual Properties of Organo-Phosphorus Insecticides on Building Materials

See PANS, 4, (3), p.379.

As a preliminary, colonies are being built up of both susceptible and resistant mosquitoes. Some difficulties were encountered with the strains of *Anopheles gambiae*; however, using slightly different conditions the colonies are thriving better.

Decomposition of chlorthion and diazinon which had been noticed previously on dried mud surfaces has been further investigated. The reaction is hydrolytic in nature and the production of 3-chloro-4-nitrophenol and 2-isopropyl-4-methyl-6-hydroxypyrimidine respectively has been demonstrated for the two insecticides. Rates of decomposition varied under different humidity conditions and on different soils. Thus diazinon on a Uganda soil at 80% R.H. had a half-life of about 2 days whereas at 20% R.H. it was 14 days. Chlorthion decomposition was much less influenced by humidity and half-lives were of the order of 2 days at either of the same two humidities. On the three soils so far tried the half-life of diazinon ranged from 2 days to 22 days at a given humidity.

Contamination of Materials by Insecticide Vapours

The factors are being investigated which influence deposition of insecticides onto various building and furnishing materials introduced into enclosures whose walls are sprayed with insecticide. Such a situation arises in houses and in aircraft. Dieldrin is the only compound to be used so far and is certainly capable of killing mosquitoes by this indirect route but the work is not sufficiently far advanced to report any details.

Sampling Insecticide Deposits on Mud Surfaces

The method which uses sodium carboxymethyl-cellulose as a film forming agent has been compared with the adhesive-tape and siliconed-paper procedures. The two earlier methods are mainly unsatisfactory because they will only function efficiently on a restricted range of wall types. The surfaces need to be relatively smooth and hard. This new technique will operate on a wider variety of surfaces but is still not suitable for the softer and/or more irregular ones. Consequently it would appear to be the method of choice at the moment but is still by no means ideal.

A Standard Emulsion Concentrate

In small-scale field trials it would frequently be a great convenience if a series of pesticides could be compared as emulsions made from a given emulsifier: solvent combination. Thereby, any influence of the different emulsifiers and solvents used in the commercial formulations upon the activity and distribution of the pesticides would be avoided. In addition formulations could be made up in the field as required.

Such a basic formula has been sought even though it was realised that the properties of a concentrate frequently depend upon the pesticide used and the difficulties usually encountered in formulation of a single pesticide were appreciated. Partial success has been achieved in that an ionic-nonionic blend with xylene as solvent has been found which passes the standard tests when 20% by weight of one of a wide variety of pesticides is added. It also emulsifies satisfactorily in waters of different hardness and over a temperature range of 13-30°C. Further work is necessary however because the present mixture is only successful with all the pesticides at a single dilution ratio of 1:20.

Agricultural Pests

The technique for breeding *Pieris brassicae* indoors has been improved. Egg production is adequate if additional lighting from a 200 watt infra-red lamp for 2 hours or from a 200 watt balanced spectrum lamp for 6 hours is provided. The maintenance of sufficient infra-red radiation and temperature seems to be necessary for mating.

A culture of *Busseola fusca*, the African maize stalk-borer has been established from a few larvae sent from Tanganyika.

Bioassay Methods for Caterpillars

The method envisaged will involve making the caterpillars walk over a deposit of insecticide for a given distance at a given rate. A possible way of controlling the movement would be by means of light stimuli and the reaction of different instar larvae of *P. brassicae* to light of different wavelengths and intensities is being investigated. Measurements of their walking rates towards white light have shown that no influence is exerted by varying the intensity of the light.

Pick-up of Particulate Deposits by Caterpillars

As a preliminary to the quantitative determination of the pick-up of solid insecticides by caterpillars it is of interest to know the sites where particles adhere and accumulate on their bodies. A method being tried at the moment is photography of a caterpillar after it has walked over salicyl-aldazine, a material which fluorescesces bright yellow in ultra-violet light.

Control of the Bean-Fly, *Melanagromyza phaseoli* (see p.130)

Aircraft

The repositioning of the hydraulic power installation of the Westland S-51 helicopter has been completed and a number of functioning trials carried out. Investigation has also begun on the amount and distribution of insecticide deposited on the under-sides of leaves by the boom and nozzle system operated at various heights and speeds.

Dispersion of Molluscicides

It was previously suggested that it might be possible to control the leaching rates of copper sulphate solutions by containing them in bags made of different types and thicknesses of plastic films. Further tests have shown that these simple systems are not so easily operated as was at first thought. The different plastic materials tried are all either too permeable or completely non-permeable to copper ions. A polyvinyl chloride film perforated with tiny holes which did give a leaching rate of roughly the right order also gave a rather variable performance in different experiments and the reasons for the variations have not so far been recognised.

COLONIAL PESTICIDES RESEARCH UNIT. ARUSHA, TANGANYIKA.
PROGRESS REPORT No. 23. APRIL-SEPTEMBER, 1958.

Insecticides

Tsetse - Field Trials

Loljoro - Experiments with Aircraft (see p.127)

Introduction of pupae. (see p.126)

Chungai - Large-scale Experiment with Aircraft

Three aircraft applications of a 5% (w/v) solution of BHC at a nominal dosage of 0.08 gal per acre have been made at monthly intervals. After the first two applications, *G.morsitans* old males showed a 90% reduction, though there is still a large number of non-teneral flies in the block. However, the intensity of pupal emergence appears to be now falling, and if so, the coming fourth application should reduce the population to a more consistently low level. So far the applications have had little effect on the *G.pallidipes* population.

Kabiganda

By the end of September the spraying of the tsetse resting places in concentration sites was virtually complete. (see PANS 4, (1), 56 and 4, (3), 385.) 1,200 gal of Dieldrex had been used and 10,130 acres covered. This works out at about ½ lb dieldrin per acre and gave a deposit on the surfaces sprayed of about 1 gram per square metre. The overall reduction of numbers of *G.morsitans* is at present about 90%.

Laboratory Work

Work on the laboratory colony of *G.morsitans* has been completed. The mean longevity of the flies has been raised to about 90 days for females and 85 days for males, and the proportion of females surviving to reproductive ages has been raised to 92%. The over-all pupa-production is approximately 2.4 pupae per female. Data have been collected on longevity, feeding habits, pupa production, and larval and pupal periods.

Mosquito-Field Trials

Taveta Pare Scheme

The fifth spraying cycle has now been completed, and the sixth and last is due to start on October 13th. It appears possible that malaria transmission is still continuing on a small scale in one part of the area where, before the scheme started, the *A.gambiae* population was exceptionally high and fed to a large extent on cattle; a detailed investigation of the position in this area is being undertaken.

Mto wa Mbu

This isolated village of about 5,000 inhabitants was sprayed with a dieldrin resin wettable powder in September 1957. The numbers of mosquitoes in the trap huts were too low for firm conclusions to be drawn but it would appear, that the non-resin formulation was rather more persistent than the resin one and that both formulations were 100% effective on sorptive and non-sorptive mud for 2-3 months and innefective after 7-9 months.

Small Scale and Laboratory Trials

Hut Experiments

Experiments are being carried out to assess the efficacy of dieldrin and BHC resin formulations on sorptive and non-sorptive mud on 16 experimental huts with walls of burnt brick lined with mud plaster and roofed with grass thatch. The natural population of A.gambiae in the area has been very low since the dry season commenced, and attempts are being made to augment it by artificial breeding places seeded with eggs from the Arusha colony; so far without any pronounced success.

Susceptibility of A.gambiae

The search for resistant A.gambiae in the Taveta-Pare scheme has been continued and as yet there is no sign of resistance to dieldrin, or even a change in susceptibility to it.

W.H.O. Test Kit

At the request of the World Health Organisation a series of tests are being carried out to assess the new larval susceptibility test kit and the wall exposures kit for adult mosquitoes. A very marked effect of temperature during the exposure period on the LC 50 of dieldrin to Aedes aegypti was noticed; a decrease of 5°C doubling the median lethal concentration. A note on this has been submitted to the World Health Organisation Bulletin.

Pseudotheraptus

In Experiment 1 at Tanga (3 pints of emulsion containing 0.1% w/v of both DDT and malathion applied weekly to the crowns of 50 palms), both V.D.R. (Vidaka Damage Rate is the number of sheds showing damage by Pseudotheraptus expressed as a percentage of the total number of nuts shed) and total number of feeding punctures have remained consistently lower for the treated palms than for the untreated controls. In the control plot there are 10-15 times as many punctures recorded, while the V.D.R. is 3-5 times that of the treated plot.

In Experiment 2 where aerial spraying is used, control is apparently less marked, but the interpretation of the results is complicated by the comparatively low damage records from the control plot. For the latest spray cycle at the end of August 1958, the dosage rate was increased to 1 gal/ac of 10% w/v DDT, and this resulted in a drop in V.D.R. from 15% to 2% in four weeks.

Other Agricultural Pests

Cotton

A full report has been written on the work on dosage distributions and persistence of insecticides on cotton. (C.P.R.U. Miscellaneous Report No. 202).

Coffee

A study on the persistence of insecticides on coffee leaves is described in C.P.R.U. Miscellaneous Report No. 204 and the persistence of parathion in coffee in No. 205.

Fungicides

Work in West Africa

An examination of chemical control of black-pod disease Phytophthora palmivora is being made. It is essential that various levels and forms of fungicide deposit, as determined chemically should be assessed biologically. A method of inoculating pods to cause multiple infections, using a technique in which the minimum redistribution of fungicide deposit occurs, is being investigated. Initial results suggest that unsprayed pods can be infected to give sufficient lesions for the method to be used as a measure of fungicide deposits.

Electroduster Trials in East Africa

The performance of the Agricola Electroduster in coffee plots has been assessed. The dust used was the proprietary "Electrocoxydust" (copper oxychloride, 8% copper). In each trial comparisons of copper deposits on the leaves from both charged and uncharged dust clouds were made.

Copper Trials at Lyamungu

The persistence and possible redistribution with time of copper spray deposits are now being studied.

Herbicides

An arboricide trial against Grevillea robusta trees is reported. Herbicide trials on the following crops are reported: pyrethrum, coffee, maize, barley, lucerne, and seed beans.

Miscellaneous

Droplet Distribution from Hollow Cane Nozzles

Details are given in C.P.R.U. Miscellaneous Report No. 206.

Drift of Toxic Chemicals

During the period several experiments have been carried out to determine the amount of toxic material, both deposited and airborne, at various distances downwind from a low flying aircraft. There were several shortcomings in technique, but useful results were obtained for distances of up to one mile from the aircraft.

IMPERIAL COLLEGE
INTERIM REPORT FOR THE PERIOD APRIL–SEPTEMBER 1958

Chemical Senses of Blood-Sucking Flies

To replace tsetse flies, cultures of Stomoxys calcitrans have been setup and the flies are being reared in large numbers. Unfed flies 1 to 2 days after emergence are used in all experiments; flies used for breeding are fed on blood plasma taken from glass pipettes. The method is proving very satisfactory.

Olfactory Stimulation

The choice chamber apparatus used for Glossina has been modified to take account of the greater sensitivity of Stomoxys to light and to gravity. Stomoxys is more active than Glossina and a photographic method of recording their distribution in the test cage has been developed; this method allows more flies to be used in one test.

Experiments have been carried out to determine which factors in the preparation of the plaster discs have the greatest effect upon the rate at which an organic stimulant leaves a dosed disc. As a result, the method of preparation of the discs has been slightly modified and carefully standardised.

An account of the work on G.morsitans, described briefly in the last annual report, is in preparation.

Tarsal Contact Chemoreception

Standard methods of presenting stimuli to the tarsal organs of taste of Stomoxys have been devised. Stimulation of the organs with appropriate solutions induces a marked probing response in hungry flies. The organs are in appearance similar to those of blowflies in which two nerve fibres are known to respond to sugars and salts respectively. The blowfly probes in response to sugars but is inhibited by salts. In contrast, Stomoxys is found to probe when stimulated with salt solutions; this correlates with the fact that Stomoxys, as a blood-feeder, normally must probe while stimulated by the salty exudations of the sweat-glands of the host.

Surprisingly it is found that Stomoxys responds even more readily to sugar solutions than to blood or salt solutions. These investigations are proceeding.

Mode of Action of Insecticides

(1) Experiments on the absorption of oil by the blowfly Phormia are continuing. The mineral oil R17, which spreads over the entire surface of a treated fly, is absorbed at a rate per unit area per hour which is about 3% that of lanoline microdrops entering over minute restricted areas of cuticle. The difference may be partly correlated with the surface activity of the lanoline constituents but other factors not yet investigated quantitatively undoubtedly play a part.

(2) It has been shown (Tobias 1946, Lewis 1953) that the acetylcholine content of DDT poisoned insects is about twice that of the normal insect. This rise, which has not been satisfactorily accounted for, could be due to one or more of the following factors -
(a) Inhibition of acetylcholinesterase, (b) Activation of choline acetylase (the enzyme synthesising acetylcholine) and (c) Activation of the lipase breaking down the acetylcholine-lipoprotein complex.

The action of chlorinated hydrocarbons on these three enzyme systems is now being further examined.

In the first instance, the effect of pp'DDT, BHC and the cyclodiene insecticides on acetylcholinesterase from the brains of Schistocerca gregaria and Phormia terraenovae has been checked. Preliminary measurements made with a Warburg manometric technique indicated a 50% increase in the activity of this enzyme upon the addition of $1.3 - 2.7 \times 10^{-3}$M DDT and $3.3 - 6.7 \times 10^{-4}$M Dieldrin and BHC. However, a possible flaw in the technique was disclosed, associated with the use of oxygen-carbon-dioxide gas mixture, and further estimations of activity were made using the more reliable pH titrometric method. This work is still in progress but the results show that at least DDT and dieldrin (at the above concentrations) neither activate nor inhibit acetylcholinesterase, contrary to the earlier findings.

(3) The staff of the Isotope School, Harwell, have very kindly co-operated in an attempt to label pp'DDT with tritium. pp'DDT was exposed to 4 curies of tritium gas which resulted in a mixture of DDT and substances (possibly tritiated) produced by the breakdown, of particle bombardment, of the DDT. This mixture is being analysed for purity, most of the DDT having been separated into one fraction by gradient elution from an alumina column by benzene-ethane. The specific activity of the tritiated DDT is about 135 micro-curies per gram. It is hoped that this preparation will be of use in tracing the spread of DDT from the site of application, and in the quantitative estimation of DDT in the finer structures of poisoned insects.

UNIVERSITY OF BRISTOL. THE ANNUAL REPORT OF THE AGRICULTURAL AND HORTICULTURAL RESEARCH STATION (THE NATIONAL FRUIT AND CIDER INSTITUTE) LONG ASHTON, BRISTOL, 1957

Aphid Control

The primary leaf curling caused by the rosy apple aphid, Sappaphis plantaginea, is the result of feeding punctures in the young petioles. While this damage may not in itself be of major importance, the curled leaves protect the aphids against inefficiently applied sprays so that colonies may increase rapidly and cause serious damage to fruitlets and new shoot growth. It was confirmed that efficiently applied BHC emulsion is able to control the aphids completely, even after initial leaf curling has occurred. Malathion at 0.025% strength, prepared as an emulsion of high wetting properties, was found superior to gamma BHC in field trials for the control of the leaf curling apple aphid and the cherry aphid, particularly in well established infestations.

Field experiments on the control of apple aphids at the "mouse-ear" and "green cluster" stages by large and small volume spraying techniques, using dilute DDT/BHC emulsions (0.05% DDT, 0.0125% BHC) and wetting agent, showed that large volume hand spraying at 400 gal per acre was superior to small volume air-flow mist spraying at 112 and 60 gal per acre. Measurements of the DDT deposited suggest that control of the aphids at the green cluster stage depends on the deposition of certain minimum quantities of insecticide at the correct site on the flower buds; insecticide deposited on the leaves has little effect at this stage. Efficient large volume hand spraying ensured effective deposition on a greater number of clusters than did the small volume air-flow method.

Spray Techniques

The study of the incorporation of surface-active agents as spray supplements has been continued. Work on the phytotoxicity of wetting agents to varieties of apples and plums has been extended to cover some 70 different materials that may be used as wetters, emulsifiers or penetrants in spray formulations. The chemical nature of all the materials used was well established so that it is possible to relate variation in phytotoxicity with variation in chemical structure of the surface-active agent. Whilst it will take some time to correlate all the results obtained, certain conclusions appear fairly obvious: non-ionic surface-active agents are far less toxic than their ionic counterparts; phytotoxicity is not directly related with wetting ability, and there appears to be a relation between the physical size of the surface-active agent molecule and the degree of phytotoxicity. Climatic conditions appear to be of only secondary importance.

Investigations into possible reactions taking place between surface-active agents and leaf surfaces show that cationic materials are adsorbed very strongly and, once adsorbed, are very difficult to remove from the leaf surfaces. This behaviour is very different from that shown by anionic materials and would indicate a greater deposition of active ingredient (insecticide etc.) on a plant surface from cationic emulsions than from anionic emulsions.

Some work has been started on the deposition on leaf surfaces of the oil phase of various emulsions. Preliminary results indicate that the physical nature of the emulsion itself is quite as important as the chemical nature of the formulation employed. This considerably complicates the direct comparison of deposits obtained from emulsions of different formulations since it necessitates a complete analysis of the oil droplet size in the emulsion under test, as well as a chemical analysis of the deposit obtained from the emulsion.

The production of spray droplets and their trajectories and impaction are now being studied, using a form of the vibrating reed sprayer.

Field trials with wetters showed that an alkyl aryl polyethyl alcohol, a non-ionic wetter, is satisfactory on all fruit crops when used at 0.025%. It is compatible with all spray materials normally used. Preliminary experiments have shown that the formulation of emulsions of high wetting properties can be modified to increase the initial retention of the toxicant: the deposit of DDT on apple leaves was increased from 2 to 8µ g. per sq.cm.

Laboratory and field investigations were carried out on the value of fluorescent materials as tracers in insecticide formulations; Saturn Yellow was found a satisfactory material in emulsions. A photographic technique was developed for recording results; it appears to provide a valuable qualitative method for rapid determinations of deposits of spray materials.

DDT

The behaviour of DDT applied in suspension, emulsion or miscible oil formulation to leaves of various kinds has been followed by recovering the deposits, after varying intervals of time, in films of the synthetic adhesive Aerolite 306. Crystals from suspensions persisted on the leaf surfaces for appreciable periods, but few crystals were present in the dried deposits of the emulsion and miscible oil formulations used.

Fungicides

Studies have been made of the mechanism of action of fungicides. Chemical tests and radioassays of Burgundy mixture prepared from ^{64}Cu have shown that a significant amount of copper is sorbed from deposits by bean leaves and that this copper is fungicidally inactive. The evidence suggests that the copper is adsorbed on the surface rather than absorbed within the leaf. The movement within leaves of copper from surface deposits was found to be negligible. The effect of the surface treated on the fungitoxicity of captan and copper spray deposits has been determined using spore germination tests on glass slides and detached leaves.

Field experiments have shown that the suppression of shoot infections of *Gloeosporium perennans* by phenyl mercury chloride is markedly improved by the addition of either linseed oil emulsion or a paint formulation of polyvinyl acetate.

In studies of the biological efficiency of fungicide spray deposits on leaf surfaces it was shown that the absence of free surface water at the time of germination and infection greatly reduced the range of action of copper spray deposits. Lime sulphur deposits, on the other hand, maintained their range of action under these conditions. The copper fungicide distribution required to prevent infection by spores arriving on an apparently dry leaf surface is more critical than that required to prevent infection in the presence of liquid water.

Eleven compounds were tested for their ability to inhibit spore germination of *Venturia inaequalis* and mycelial growth of *Sclerotinia laxa*. On the basis of these preliminary tests, *n*-dodecyl-guanidine acetate, 2:4-dichloro-6(*o*-chloroanilino)-*s*-triazine and *o*-hydroxy-diphenyl appear to warrant field testing; the latter compound, however, was liable to cause phytotoxicity at 0.1%.

WESTERN SOKOTO MALARIA CONTROL PILOT PROJECT. - INSECTICIDE CHEMISTRY LABORATORY. QUARTERLY REPORT FOR THE PERIOD APRIL 1st, 1958, to JUNE 30th, 1958.

Persistence of Insecticides on Mud Surfaces. (See P.A.N.S. (A), 4, (3), p.395).

The final sampling of the three series of mud blocks sprayed with DDT, BHC, dieldrin and dieldrin-resin water-dispersible powders was made 81 days after the initial spraying. The blocks were maintained throughout the experiment at 27-29°C and 81-85° relative humidity.

Persistence of DDT, BHC, dieldrin and dieldrin-resin water-dispersible formulations on mud blocks at 85% relative humidity

Interval after spraying (days)	DDT g/m^2			Dieldrin-resin mg/m^2		
	Argungu	Birnin-Kebbi	Yaba	Argungu	Birnin-Kebbi	Yaba
81	0.54	1.07	0.70	53	53	77

The surface deposits on the BHC and dieldrin treatments were less than 0.5 mg/m^2 - the smallest amount detectable by the technique used.

The bioassay results on the mud blocks show that under humid conditions there is little difference in the residual toxicity of the three normal water-dispersible formulations on the Argungu and Birnin-Kebbi muds. However, DDT, sprayed at 2.35 g/m^2 pp'DDT, shows a greater residual toxicity on the more sorptive Yaba mud than do either BHC or dieldrin sprayed at 0.41 and 0.48 g/m^2 respectively. In contrast to the trend towards decreased residual toxicity of BHC and dieldrin on Yaba mud, DDT exhibits no significant difference in the rate of sorption or residual toxicity on any of the three muds.

Although no BHC or dieldrin can be detected chemically at day 9 and day 27 respectively, the surfaces are still lethal suggesting that dieldrin may have a fumigant toxicity like BHC.

There is a significant difference, both in the rate of sorption and residual toxicity, between the two dieldrin formulations. Between days 3 and 81 there is an approximately constant surface deposit of dieldrin from the resin formulation of 57, 56 and 69 mg/m^2 on the Argungu, Birnin Kebbi and Yaba muds respectively. After 9 days no surface deposit of dieldrin from the normal water-dispersible powder can be detected and the toxicity of the surface is decreasing at day 65. The dieldrin-resin formulation gives a surface deposit which is as toxic as that of DDT 81 days after application.

Effect of a Change in the Relative Humidity on the Persistence of DDT, BHC, and Dieldrin on Mud Surfaces.

Eight mud blocks, prepared from the same samples of the Yaba mud as used in the previous experiment, were left to dry out for two months in an air conditioned room at 26-28°C and 50-54% relative humidity. Duplicate blocks were sprayed with DDT, BHC, dieldrin and dieldrin-resin water-dispersible powders respectively. Surface sampling and bioassays were carried out. After day 57 the blocks were moved into a room at 29-31°C and 83-86% relative humidity - the normal Lagos conditions. The blocks were bioassayed one week later at day 65.

The results confirmed the observations of Barlow and Hadaway that the sorption of insecticide particles from mud surfaces increases as the humidity decreases. (see PANS (A), _3_, (4), pp.260-1).

The average rate of sorption of the three insecticides over the first nine days in mg. per day per square meter is: dieldrin > 26, DDT $\geq$ 70 and BHC > 70. The corresponding rates at the high humidity were dieldrin 15 mg., DDT 23 mg., and BHC 63 mg.

"The residual toxicity of all the treatments was greatly reduced at the lower relative humidity; BHC alone maintained a high kill at day 57 with a 20 minute exposure. Between days 3 and 57 the dieldrin-resin formulation showed an approximately constant surface deposit of 100 mg/m^2. The toxicity, however, was not as great as under humid conditions.

On raising the relative humidity the residual toxicity of all the formulations was increased. The increase in residual toxicity, when the relative humidity increases from 50 to 80% is most likely associated with the fact that clays commence to absorb water from the vapour phase when the relative humidity exceeds 50% (Gregg. Surface Chemistry of Solids, p.38).

From these observations it seems that the relative humidity has a more significant influence on the residual toxicity of insecticide deposits on mud surfaces, than the nature of the mud itself."

Relationship Between the Particle Size of Building Muds and Sorption.

"Preliminary work had indicated a possible correlation between the specific surface area of a building mud and the sorption of insecticides. To test this hypothesis five different muds from Nigeria and one from India were divided into four particle size fractions by sieving; below 66 microns (No. 4); 66-104 microns (No. 3); 104-251 microns (No. 2) and 251-442 microns (No. 1). The fractions above 66 microns, Nos. 1, 2, and 3 were ground in a ball mill to pass the 66 microns, sieve. The fractions were made into circular blocks (12 cm diameter and 1.2 cm thick) and dried out at 26-28°C and 50-54% relative humidity for three months. The blocks were sprayed with a 75% DDT water-dispersible powder at a dosage of 1.38 g/m^2 technical DDT. Five weeks after spraying the surfaces were bioassayed; 30 minute exposures were given."

In the case of muds from Northern Nigeria sorption only occurred in the No. 4 or colloidal fraction; but in two muds from Southern Nigeria fraction 3 was also sorptive, and in one of these No. 2 as well. The surface areas of these lower fractions ranged from 5 to 9 m^2/g and may be large enough for van der Waals absorption. (The surface areas of the No. 4 fractions are all greater than 15 m^2/g.)

If sorptive behaviour was entirely due to the specific surface area of mud, the Indian mud, where No. 4 fraction had the greatest surface area (64 m^2/g) should be the most sorptive, but this was not so. It is noteworthy that the Indian fraction produced a large evolution of heat when mixed with water - a reaction typical of physical adsorbants.

"All the sorptive fractions however are characterised by having high iron oxide and/or alumina contents, the proportion of both iron oxide and alumina increasing with decreasing particle size. It has sometimes been suggested that sorption could be correlated with iron oxide content; this would not explain the sorptive properties of alumina. Nevertheless for the group of muds examined it appears empirically that sorption of DDT is associated with a high iron oxide and/or alumina content of the mud, but for muds of low iron oxide content the proportion of alumina must be considerably greater than that of the iron oxide; i.e. the sorptive 'power' of iron oxide in a mud is greater than that of an equivalent amount of alumina."

"Although the indications are that the sorption of DDT is associated ultimately with the surface area of the sorbent, the forces controlling the uptake may be in part van der Waals forces, and in part electrostatic due to the attraction and repulsion between the ions of the mud and the dipoles of the insecticides."

Vapour Toxicity and Fumigant Effect of DDT, gamma BHC, Dieldrin and Dieldrin-Resin

Cylindrical mud blocks, which had been left to dry out for 3 months, were sprayed with water dispersible powders at the following dosages, 2.03 g/m^2, technical DDT, 0.54 g/m^2 gamma-BHC, 0.31 g/m^2 dieldrin and 0.26 g/m^2 dieldrin-resin. After storage for 6 days they were tested in a fumigant apparatus against female Aedes aegypti. Examination of 24 hour mortalities showed that like gamma BHC, both DDT and dieldrin produce lethal concentrations of vapour at the mud surface.

This vapour effect would explain the observations that although no dieldrin can be detected on the surface of the mud block, the surface still retains its toxicity. There is no difference between the two dieldrin formulations in their vapour toxicity.

Insecticide Deposits in Western Sokoto

A comparison was made between deposits on sample papers exposed in houses to be sprayed.

To ascertain whether the use of sample papers exposed in houses to be sprayed gave biased results due to overspraying, wall scrapings were taken without the knowledge of the overseer. In one case there was a significant difference between the two methods, indicating that extreme care must be taken when evaluating dosage rates assessed from sample papers.

FILARIASIS RESEARCH UNIT, FIJI

INTERIM REPORT FOR THE PERIOD APRIL-SEPTEMBER 1958

Field work

Mau village was again sprayed with dieldrin in May. The deposit was estimated at 143 mgm/sq.ft. Catches by pyrethrum fogging and night hand catches continued.

At Wainiabia, felling of wild pandanus for 300 yards has not exterminated Aedes fijiensis and has now been extended to 500 yards. If this is not successful cultivated pandanus would need to be cut.

Bush infections

A higher infection rate is often obtained in mosquitoes caught 100-400 yards from villages, along paths, than within 100 yards. This may be relatively unimportant if the actual numbers are lower and if a false impression of the density on the path is given because there is less opportunity to feed, causing an accumulation of hungry mosquitoes which flock to the bait as he appears. If this is true there should be a marked reduction in catches through the day if the bait is regularly proffered. A series of catches each of 5 minutes at each of 6 stations was made at Nukui at two hour intervals (a) within 100 yards of the village boundary (b) along a path up to 400 yards from the village. Catches were as follows:-

Time	7 a.m.	9	11	1 p.m.	3	5	mean
Near village	118	115	88	58	88	79	91
Track catch	125	94	95	96	133	127	112

Crab control

Rice bran is reported to be a satisfactory bait and BHC the most promising poison.

Drug treatment

In the Taveuni experiment 76 persons were treated with twelve weekly doses each of 300 mgm. hetrazan citrate. After 18 months only 36% were cured but the microfilarial load decreased by 98%.

In the Rewa area, where mass drug administration is being undertaken, the first dose of hetrazan (adult dose 400 mgm. citrate, six times at weekly intervals) was given in July and August. Blood samples taken in May showed an infection rate of 13.4%. Mosquito dissections gave the following infection rates:-

Infection rate	*Aedes pseudoscutellaris* & *A.polynesiensis*		*A.fijiensis*		*Culex fatigans*	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Crude	2.6%	0.9%	0%	-	2.6%	0%
Mature	0.36%	0.2%	0%	-	0%	0%

WEST AFRICAN COCOA RESEARCH INSTITUTE

QUARTERLY PROGRESS REPORT NO. 50, APRIL-JUNE, 1958

Pathology Division: Virus disease of cacao in Sierra Leone

An outbreak of a virus disease of cacao, transmitted both by grafting and by the mealybug, *Pseudococcus njalensis*, has been discovered in Sierra Leone. Recommended control measures were the cutting out of all infected trees and of symptom-free cacao within 30 yds of the perimeter of the outbreak.

Entomology Division: Capsid studies

A new series of trials has been set up to compare the relative effectiveness of these insecticides applied at rates rougly proportional to their cost. These are; endrin at ½ oz/ac, gamma BHC at 1 oz/ac, and aldrin at 2 oz/ac. The first treatment will be at twice these rates. In a fourth experiment gamma BHC is to be applied at 1 oz/ac with a single dosage rate throughout. Each treatment, and control, will be replicated five times: the individual plots are of 3-4 acres.

Mealybug studies (See P.A.N.S. 4(4) p.455)

It is stated that as routine capsid control measures with gamma BHC will be carried out in the Oyoko area, it is now unnecessary for dieldrin to be applied to the canopy. Accordingly, in the first application of a second double treatment, 14 months after the original treatment, dieldrin was applied at the rate of 1 lb in only 20 gal. water/ac.

Ant/Mealybug Control Trial - Series II

The Square Mile trial illustrated the inadequacy of one application of dieldrin emulsion in effecting an acceptable reduction in vector populations through ant control. In June, a new trial was laid down in the W.A.C.R.I. Square Mile and pre-treatment counts of ants and mealybugs begun. A dieldrin/coumarone formulation will be compared with straight dieldrin emulsion. The dieldrin/coumarone application will consist of 1 lb dieldrin plus 10% coumarone by weight in 20 ga/water/ac applied to the trunks of all trees.

Three replicates of each of the two insecticidal treatments and three of a control are planned. Each plot is of 10 acres and consists of 3-5 acres cacao, the remainder being bush. About 200 trees along diagonal transects will be examined for ants in each plot. Fortnightly estimates of mealybug populations will be made by random felling of trees having a girth of at least 8 ins. in 50 ft square sub-plots in the cacao areas.

ANNUAL REPORT OF THE WEST AFRICAN RICE RESEARCH STATION - 1957

Seed Dressings

Previously when Agrocide dispersible powder (containing technical benzene hexachloride) was used as a seed dressing, characteristic abnormalities developed in rice seedlings if the seeds were set to germinate after two months' storage. These deformities became more severe the longer the seeds were stored.

Further investigations have now been carried out using the pure gamma isomer of BHC and it has been shown that when seedlings are grown in solutions of this substance the same symptoms develop as when seed is germinated after storage with Agrocide used as a seed dressing. Seeds which have been stored in Agrocide (1 gram per 8 oz of seed - which gives a weight ratio of gamma-BHC to seed of 1:3,488) for nine months show symptoms of germination which are equivalent to those produced in undressed seed grown in solutions of between 28.4 and 284 parts per million of gamma-BHC. It appears, therefore, that when rice seed is stored in BHC, the gamma isomer, and possibly other isomers, is absorbed by the seed until a level is reached which causes deformities.

The type of deformity produced, together with a recent suggestion by MacLagan that BHC might act as an auxin under certain circumstances, suggested that the deformities in rice seedlings might also be due to auxin activity of BHC. Further experiments were therefore carried out in which a comparison was made between the effects of gamma-BHC and various substances which are known to have auxin activity. These investigations showed, however, that apart from inhibition of root growth at the same order of concentration, there were no similarities between the effects of gamma-BHC and substances with auxin activity. These latter substances had additional properties not shown by gamma-BHC and at appropriate concentrations caused the production of an epicotyl and reversals of coleoptile geotropism.

THE EFFECT OF REPEATED INSECTICIDAL APPLICATIONS ON A NATURAL TSETSE POPULATION

D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika.
H. R. SIMPSON. Rothamsted Experimental Station.
Arusha Misc. Report No. 207.

The effect of repeated applications of a non-persistent insecticide on a natural tsetse population is examined theoretically. Calculations show that the number of applications, and the kill per application, have pronounced effects upon the final reduction in population. It also appears that the greatest reductions are obtained if the interval between successive applications is equal in length to the pupal period.

THE ESTABLISHMENT OF THE TSETSE FLY G.MORSITANS IN AN ALIEN HABITAT

R. FOSTER. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Misc. Report No. 212.

This report describes the introduction of pupae of Glossina morsi morsitans into a block of 110 acres at Loljoro in the hope that an isolated, artificial population of morsitans would be established for testing the effectiveness of aerial applications of insecticide (see p. 127). The indigenous species of this area is swynnertoni and the nearest morsitans area is about 70 miles away.

On March 18th, 940 morsitans pupae, collected from Singida, were introduced at two sites in the block. The pupae were covered with a thin layer of sand, and shielded from the sun by grass and fallen logs. Data from preliminary observations indicated that morsitans could survive and further batches of 880, 2,800 and 2,000 pupae were introduced on May 12th, 19th and 26th respectively. The adult population built-up rapidly, reaching a maximum Apparent Density of 78 during the week ending June 3rd.

When gamma BHC was applied on June 3rd, there was an immediate reduction of 98-99% in the population of morsitans old males. Although no further pupae were introduced, by the end of September the Apparent Density was comparable with that immediately after the treatment. The continued catching of both old and young flies indicates that the survivors of the insecticide treatment (and probably a number of flies which emerged after the treatment) are living and reproducing in the block. Whether the flies will survive the entire long dry season is not yet known.

AIRCRAFT APPLICATIONS OF INSECTICIDE TO A TSETSE HABITAT; THE AUSTER J.5G AIRCRAFT

R. Foster. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Misc. Report No. 213.

This report describes the aerial application of insecticides to blocks of woodland infested with *Glossina swynnertoni*. In the first experiment, Block 1 (280 acres) was treated in February 1958 with a 5% (w/v) solution of gamma BHC in kerosene at a nominal dosage of 0.08 gal/ac (see PANS, 4, (3), 383-4).

In a further experiment a population of *G.morsitans* was introduced into Block 2 of 110 acres (see p. 126). Spraying with BHC was carried out on June 3rd. The kill of *swynnertoni* old males was 96-97% in the immediate post-treatment period. The A.D.ø remained low for about two months before rising sharply. The kill of *morsitans* old males was 98-99%. No 'recovery' of the population has taken place as no further pupae have been introduced; the survivors of the spraying were living and reproducing at the end of September.

On June 2nd, 1958 Block 1 was again treated, this time with a 5% solution of dieldrin at a nominal dosage of 0.08 gal/ac. There was no immediate and dramatic kill of *swynnertoni* as was noted with the gamma BHC treatments but the A.D. fell progressively for about four days after treatment. The value reached on June 6th represented a 97% kill of old males. The A.D. of the population again remained at a low level for about two months.

Calculations suggest that the interval between applications can profitably be increased to about four weeks. Tests with BHC are now being carried out on the twelve square mile block at Chungai (see p.111).

ø The term Apparent Density (A.D.) is conveniently used to denote the (calculated) number of mature male flies captured per 10,000 yds of fly-route traversed.

LABORATORY COLONIES OF THE TSETSE FLY GLOSSINA MORSITANS

R. FOSTER. Colonial Pesticides Research Unit, Arusha. Tanganyika. Misc. Report No. 214.

In earlier attempts to maintain a breeding colony of Glossina morsitans in the laboratory, flies were kept at room temperature which fluctuated from 73-80°F (colony 1) and later in a crudely controlled cabinet at 77-9°F (colony 2). More recently two colonies (3 and 4) have been maintained simultaneously in electrically controlled incubators at a constant temperature of 79°F. The maintenance technique was similar to that used previously except that (a) the temperature during feeding was more strictly controlled at 81°F., (b) greater care in handling and more diligence in feeding the flies was exercised, and (c) the inter-feed period was altered. In view of the previous finding that the inter-larval period is dependent not only on the temperature but also on the length of the longest foodless interval during the inter-larval period, the flies in colony 3 were offered food every third day and those in colony 4 every second day. (The flies in colony 1 were fed every fourth day.) Sheep were used throughout as the principal feeding-animal, although flies which persistently refused to feed for three days or more were often induced to feed on guinea-pig, after which they were returned to the regular routine on sheep.

The data from colony 4 showed marked improvements over those from previous colonies. The mean length of life of the flies was raised to 67.8 and 87.6 days for males and females respectively, compared with 41.0 and 60.8 days respectively in colony 1. Female survival data showed that survival was logarithmic with time up to about 100 days (50% survival), after which mortality increased markedly. It is interesting to note that pupa production in this colony declined in females of over 100 days of age. The longest-lived fly in colony 3 survived for 226 days.

In colony 3, there was improved survival of the young flies, the proportion dying during the first month of life being 25.2% and 17.4% for males and females as against 63.3% and 58.6% respectively. This led to an increase from 27% to 62% in the proportion of females which produced pupae.

In colony 4 (where food was offered every second day) the mean longevity was further raised to 85.4 and 90.0 days for males and females respectively. It is of interest that this is the first occasion, in laboratory colonies, on which males and females have shown anything approaching an equality of longevity. The death rate among young flies was further reduced in colony 4, less than 5% of these flies dying before reaching an age of 11 days, and only 15.9% of the males and 9.7% of the females dying during the first 30 days after emergence. The longest lived fly in colony 4 survived for 257 days.

The improvements noted in colony 4 led to the proportion of females which survived to reproductive age being further raised to 92%, and 70% of the female flies in this colony produced pupae. The mean number of pupae per female was consequently raised to 2.38 (1.25 in colony 1). In order that a colony may maintain itself without the addition of wild pupae, each female fly must produce two or more pupae, and these pupae must hatch to give viable adults. Such production was achieved in colonies 3 and 4, but 100% successful emergence of pupae has not been recorded. Most of the pupae from the flies of colonies 3 and 4 were maintained at the current room temperature and humidity (73-80°F. and 60-70% R.H.), and of these pupae 70% hatched to give apparently viable results.

Although the survival and hence the overall pupa production figures of colony 4 surpass those of the earlier colonies, the pupa production figures for females of reproductive age and for "producing females" are lower than some previously recorded; in fact, for females of reproductive age and for "producing females", the greatest productivities were observed in colony 1. No suggestion is made as to the reason for these lower values in the later colonies, as conditions appeared generally to be more favourable than those operating previously.

On the basis of the described methods it is now possible to hatch and successfully maintain adult "savannah tsetse" in the laboratory for experimental purposes.

OBSERVATIONS ON A MICROFILARIA OF FRUIT BATS (PTEROPUS HAWAIIENSIS) IN FIJI

C. B. SYMES and J. U. MATAIKA. Filariasis Research Unit, Fiji.

During studies of human filariasis in Fiji in 1954-6 a new microfilaria named Microfilaria fijiensis was found in the blood of 38 bats. Like the Pacific form of W.bancrofti this microfilaria shows periodicity. A possible vector was thought to be Cyclopodia inolita, a Nycteribiid present on the bats but none were seen in dissections. In dissections of wild mosquitoes one infection in A.polynesiensis was possibly M.fijiensis. Laboratory infections were made with various mosquitoes but none tested were good intermediate hosts.

DROPLET DISTRIBUTIONS FROM FLAT-SPRAY NOZZLES FITTED TO AIRCRAFT

D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika.

An investigation has been made of the droplet distributions produced by flat-spray nozzles fitted to aircraft. Combined with a dimensional analysis of the process of droplet production, the experimental data have enabled a useful correlation to be obtained between the Sauter mean diameter of the droplet distribution, the volume and velocity of emission of liquid, the velocity of the liquid relative to the stationary air, and the surface tension and density of the liquid. Viscosity appears to be unimportant for values at least as high as 0.12 poise, although this may not be true for operating pressures much below 20 p.s.i. It is considered unwise to extrapolate beyond the limits of the investigation, and these are recorded. A comparison is made with the results of other workers.

INSECTICIDE SEED DRESSINGS FOR BEAN FLY CONTROL

P. T. WALKER. Colonial Pesticides Research Unit, Porton.
Report No. 158.

Four field trials were carried out in the Arusha District of Tanganyika in 1957 on dwarf haricot-type beans, Phaseolus vulgaris against the bean fly, Melanagromyza phaseoli. The following insecticidal treatments were used:

1. Aldrin wettable powder, as a dry dressing, 32% aldrin w/w, applied at the rate of 3 g. dressing per 1 lb seed.

2. Aldrin emulsifiable concentrate (EC), wet dressing, 25.65% of aldrin w/v, applied at the rate of 3.8 ml., made up to 5 ml with water, to 1 lb of seed.

3. Aldrin wettable powder as a wet dressing. Applied as in No. 1 but with the addition of 5 ml. water to the dressed seed.

4. Endrin EC, wet dressing, 21% endrin w/v 4.6 ml. made up to 5 ml. with water, applied to 1 lb of seed.

5. gamma-benzene hexachloride (BHC), dry dressing, (proprietary mercurial gamma-BHC dressing), 45.9% of gamma-BHC w/w applied at 3 g. dressing per 1 lb of seed.

6. gamma-BHC EC., wet dressing, 19.5% gamma-BHC w/v 4.6 ml. made up to 5 ml. with water, applied to 1 lb seed.

7. Dieldrin, dry dressing, (a proprietary mercurial dieldrin dressing), 17.2% dieldrin w/w applied at 2 g. per 1 lb of seed.

8. Dieldrin EC, wet dressing, 17.8% dieldrin w/v, undiluted, at a rate of 5.4 ml. per 1 lb of seed.

9. V.P. 2823. A phosphatic systemic dry dressing of unknown concentration and constitution applied at the rate of 2 g. per 1 lb of seed beans.

10. Control - no dressing.

The concentration of the active ingredient given was determined chemically. In treatments 1 to 4 and 8 the rates of application were calculated as being equivalent to approx. 200 mg/100 g seed beans; for treatment 5 (BHC, dry) approx. 300 mg. and treatment 7 (dieldrin) 76 mg.

Method of Treatment

Dry treatments were applied by sprinkling the required amount of seed dressing powder over the seed beans and shaking for a constant time. No excessive residue of dressing was found at these rates although not all was taken up by the seeds. Wet dressings were similarly agitated in a closed container for a constant time for each treatment, the minimum time necessary to give uniform wetting. A volume of 5 ml. of liquid was found to wet 1 lb of seed uniformly without any liquid residue. The wet seeds were then immediately spread out on hessian (sacking) to dry. In treatment No. 3 seeds were dressed dry with a dressing of a wettable powder (aldrin) and then wet with the same amount of liquid, in this case water, as the wet dressing and then dried. This is similar to the slurry method of dressing seeds with dry seed dressings.

Analysis of Uptake

Analysis of dressed seeds remaining in the hopper after drilling showed that approx. 50% of the insecticide was recovered after wet dressing compared with 25% after dry dressing. For greater uptake of insecticides, therefore, seeds should be treated with either a liquid formulation or should be moistened after dry dressing.

Effect on Germination

Treatment caused a 5% reduction in the germination rate compared with the untreated seed germination rate of 90%. Seeds treated with the BHC wet dressing germinated 5 days later than the rest.

Planting Details

Trial A was planted on a red clay soil in the usually drier area of the Loljoro valley, Trial B on black clay soil on the wetter slopes of Mount Meru at Usa River. Trials C and D were in the Olmontonyi area of Arusha and planted on porous volcanic soils, with average rainfall expectation.

A Planet seed drill was used to hand drill the plots, the hopper being cleaned out between treatments. Seeds were planted to a depth of one to two inches and at a rate of about 26 lb of seed per acre. Plots were planted during the rains, the first, Trial A, on the 8th April, 1957, B on the 10th April, C on the 3rd May and D on the 4th May. Due to heavy rain it was impossible to reach trial A until the 13th May, when the first pupae were found. Samples from this trial were taken for damage estimation on the 25th May. Trial A was harvested on 11th July, C on the 19th August, and D at the end of August, 1957. Trial B could not be harvested but a record of damage was taken on the 31st May.

Infestation and Damage Assessment

Samples of ten plants per replicate, amounting to forty plants per treatment, were pulled up and taken to the laboratory. The number infested by bean fly, the number of larvae and pupae found on examination and dissection, and the degree of damage, were recorded. The degree of damage was given a rating: 0,1 for a little and 2 for severe, based on the extent of splitting and rotting of the stem and root. The rated degrees of damage gave the most sensitive estimate of the effects of the different treatments, so they alone were analysed. Percentage attack (on 40 plants) ranged from 2.5% (treatment No. 4, endrin) to 92.5% on controls. The number of larvae and pupae found per 40 plants ranged from nil (treatment No. 4, endrin) to 43 (treatment No. 9 organophosphorus insecticide). Damage ratings were expressed as a fraction of the maximum possible score and transformed to angles.

An examination of the results showed that endrin (treatment 4) is consistently superior in effect to all the other treatments, reducing damage from a control rating of 52.6 to 7.7 units. Among the others, aldrin as a wetted dry-dressing (No. 3) was appreciably more effective than aldrin as a wet dressing (No. 2) which in turn is better than aldrin dry dressing (No. 1).

Yields

Yields were recorded from three of the trials (see Table). The conclusions to be drawn from yields alone are as follows. Endrin gives the highest yields, being most effective under the poorer conditions of trial A. There is no statistical difference between endrin and aldrin as a wet dressing, the next lower yielding treatment. All the insecticides gave greater yields than the controls except a wet dressing of dieldrin, a dry dressing of gamma-BHC and the organo-phosphorus dry dressing V.P. The method of wet dressing, as a whole, was more effective than dry dressing with the same insecticides.

General Conclusions

If the combined responses of reduction of damage and increase in yields are examined for all the trials, in order to discover an overall effect, the eight effective treatments appear in the order shown:

The treatments in Order of Effect (as a Percentage of the Most Effective), together with the Percentage (w/w of Seed) of Insecticide (a.i.) on the Seeds (Mean of Two Analyses).

Treatment No.	Effect	Insecticide
4. (endrin, wet)	100	0.111
2. (aldrin, wet)	91	0.113
3. (aldrin, wet/dry)	86	0.135
6. (gamma-BHC, wet)	85	0.114
7. (dieldrin, dry)		0.023
1. (aldrin, dry)	78	0.043
8. (dieldrin, wet)	76	0.099
5. (gamma-BHC, dry)	67	0.074
10. control	57	-

Mean Yields of Pods for Three Trials, with their Respective Standard Errors, in Ounces per Area of Treatment

Treatment and No.	TRIAL A			TRIAL C			TRIAL D			MEAN OF 3 TRIALS			
	dry	wet	mean	dry	wet	mean	dry	wet	mean		dry	wet	mean
	± 1.09		±0.77	±1.09		±0.77	±1.09		±0.77		±0.63		±0.45
Aldrin (1 & 2)	4.3	5.3	4.8	18.9	19.1	19.0	8.5	15.0	11.7		10.6	13.1	11.85
gamma-BHC (5 & 6)	3.6	4.3	3.9	14.7	16.9	10.8	7.8	13.5	10.6		8.7	11.6.	10.13
Dieldrin (7 & 8)	4.4	4.8	4.6	16.7	11.5	14.1	10.1	10.1	10.1		10.4	8.8	9.6
Mean 0.63	4.1	4.8		16.8	15.8		8.8	12.9		0.36	9.9	11.2	
Endrin, wet (4)	6.3 ± 1.09			20.8 ± 1.09			13.2 ± 1.09			13.5 ± 0.63			
Aldrin, wet/dry (3)	2.6 "			18.7 "			10.1 "			10.5 "			
VP (9)	1.9 "			16.9 "			9.3 "			9.4 "			
Control (10)	3.7 "			13.7 "			8.4 "			8.6 "			

Thus the most effective treatment was dressing with endrin emulsifiable concentrate (wet) at approx. 200 mg. endrin/100 g. of seed, of which about 50% (0.111% by weight of seed), was carried on the seeds, reduced damage from a rating of 52.6 to 7.7 and increased yields from 8.6 to 13.5.

In reducing damage, all treatments were statistically more significant in effect that the control except an organo-phosphorus dry dressing. Aldrin as a damped dry dressing at 0.135% of aldrin w/w of seed was more effective than aldrin (wet) at 0.113%; dieldrin as wet and dry dressing was slightly less effective than aldrin; gamma-BHC was less effective than either overall.

The yields show no statistical differences between aldrin (wet) and endrin (wet), but those two are just more effective than gamma-BHC (wet). Wet dressing as a whole was more effective than dry dressing.

In general the method is effective, and most valuable where growing conditions are unfavourable.

REVIEW ARTICLE

THE PROOFING OF TEXTILES AGAINST ATTACK BY INSECTS AND MICRO-ORGANISMS

D. J. COLWILL. Colonial Pesticides Information Service. January, 1959.

Introduction

This article relates to the proofing of textile and cordage material of animal and vegetable origin against attack by insects and micro-organisms.

The principle is to render the fabric unsusceptible to attack, by chemically treating or modifying the chemical constituent of the inherent fibre, essentially cellose in vegetable fibre and protein (especially keratin), in that of animal origin.

Vegetable fibres such as cotton, jute and sisal are readily subject under favourable climatic conditions to attack by cellulolytic organisms and bacteria. Incipient damage is indicated by the appearance of mildew which unchecked, can lead to serious disintegration (rotting) of the fabric. There are numerous descriptions in the literature of the organisms involved, and a recent account (46) underlines the diversity and complexity of microbial attack. Damage caused by insects is less marked and is chiefly by the termite and to a lesser extent by thysanurids such as the silverfish (*Lepisma saccharina*) and the firebrat (*Thermobia domestica*).

Insect pests, notably the larvae of certain Lepidoptera and Coleoptera, constitute the main threat to fabrics woven from animal fibres, such as wool and silk. Here microbial damage is of less significance but may occur during certain stages of processing and in tropical storage.

Damp, excessive heat and sunlight accelerate the microbiological deterioration of textiles. In addition, chemical corrosion and mechanical stresses (internal and external) contribute to the rate of decay of cordage. It is not surprising therefore that attempts have long been made to overcome this problem of decay by artificial means. Rope, one of the first products of man's creativeness, has been chemically protected with tars, gums and pitch for many centuries; today such products have been largely superseded by compounds of greater effect which also can be handled more conveniently.

In the proofing of textiles the basic fibre and the conditions of use are major factors governing the choice of a suitable preservative and several types of chemical compounds are now available for this purpose. These range from products suitable for the short term preservation of light textiles in store to the full term protection of heavy fabrics destined for use under severe exposure conditions. The difficulty in obtaining full protection is considerably increased when micro-organismal attack is allied to the effect of weather exposure. (64).

Chemical Preservatives

It proves convenient when screening chemicals to postulate a model substance possessing the ideal set of properties. A textile preservative (13, 60, 93) should be:

1. Highly toxic to the insects and micro-organisms likely to cause decay
2. Non-poisonous to man
3. Permanent (hence chemically stable, non-volatile, resistant to leaching and unaffected by handling or cleaning)
4. Without detriment to the colour or strength of the fabric or to other, subsequent finishes.
5. Fast to exposure (i.e. effects of air, sunlight and moisture).
6. Colourless, or nearly so.
7. Odourless, or at least without objectionable odour.
8. Capable of being applied easily and uniformly.
9. Economical.

Preservatives in service today fulfil many of these requirements, but all fall short of the ideal and several are severely restricted by lack of one or more properties.

Chemicals of inorganic origin were frequently employed in early preservative processes, and modifications are still in force in many parts of the world. The last few decades have seen the growth of more intensive research into preservation techniques, stimulated by market competition and the development of synthetic fibres. Inorganics are gradually losing ground to the organics, particularly in the U.K. and the U.S.A. (51).

The principal organic preservatives include several organo-metallics (mainly with copper) and compounds containing chlorine or phenolic groups or both.

Protection against Attack by Micro-organisms

Inorganic compounds: Cuprammonium salt complexes (e.g. hydroxide, carbonate, fluoride) have been extensively used on canvas, duck and hessian, and are generally incorporated at not less than 1% wt. on the dry fibre (71). The effectiveness of cuprammonium treatment is impaired on weathering, through loss of copper. This is partly offset by the addition of inorganic chromium, which also enhances the resistance to actinic breakdown (13). Chromium alone is less effective than copper. Chromium-iron and antimony combinations have been used to counteract photochemical effects (60). Mineral khaki consists of chromic and ferric oxide mixtures.

Organic metallic compounds of copper: Copper-8-hydroxyquinolate (Copper-8-quinolinolate, "Copper 8") is an outstanding preservative. It is insoluble in water and is generally formulated for use in solvent, O/W or W/O emulsion, or water dispersible form. It is sometimes applied in situ by the double diffusion process. It is highly efficient in protecting fabrics, exposed to outdoor environments, at very low concentrations (0.15-0.2% copper/dry wt. fabric). It is suitable for application to canvas, webbing, firehose, threads and yarns, and is conceded to be extremely effective as a cordage preservative, being readily adaptable to rope manufacturing operations (47). It is not compatible with fabric coatings of natural rubber but is without effect on the physical properties of synthetic rubbers such as Neoprene or GR-S. The compound is relatively odourless, of a pale greenish-brown colour, non-toxic and able to impart actinic resistance. Its wider application is precluded only by cost. Several industrially available preservatives are based on this compound; these are usually formulated with emulsifier (i.e. "solublised"). Examples are the "Cunilates" manufactured by Cuprinol Ltd. (24) and "Quindex" (Nuodex Products Co. Inc.) (77).

Copper naphthenate is widely established as a primary cordage fungicide (47, 71). Its more general use is limited by its colour (bright green), odour, and its tendency to impart a greasy stiff handle and to stain other fabrics. The compound is without detriment at the recommended concentrations (0.50.8% wt. copper on dry fabric) (93). Copper loss on weathering is appreciable unless a protective binder, such as wax, is incorporated (13). Creosote is occasionally added to improve its leaching fastness on heavy cotton and flax canvas. The types of merchandise for which it is well suited include sacking, rope, cordage and canvas tenting. It cannot be used in the presence of a rubber coating which it will gradually cause to disintegrate.

Several other copper soaps are available with properties similar to those of copper naphthenate. These include the oleate, ricincleate, tallate, resinate and hydroxy-naphthenate.

A number of new copper salts which possess interesting possibilities has been introduced: copper pentachlorphenate, which has excellent fungicidal properties but lacks resistance to outdoor weathering; cupferron, a complex of N-nitroso N phenyl hydroxylamine (commercially available (77) as "Fungitrol 25") having a low mammalian toxicity and only slight colour; copper-3-phenyl salicylate (P.A.N.S. A 1957 3 (4) p. 318) approved by the U.S. Army for use on cotton duck and twill (39); and copper formate which is reputed to impart prolonged mildew resistance (60).

Other organo metallic compounds: After the copper preservatives, zinc soaps are produced in appreciable quantities. The fungicidal effect of zinc is less marked and more specific than that of copper. Zinc fungicides are most effective against *Poria* (found in mines) and *Coniphora* (cellar fungus). Zinc naphthenate is the preferred fungicide for the treatment of filter cloth (flannel) in an underground mine environment (60). Zinc soaps are brownish in colour and may be used when it is desired to avoid the green staining caused by copper.

"Fungitrol 50" is an amber coloured liquid fungicide preparation with a slight bland odour based on a synergistic mixture of zinc napthenate (5% zinc) and dehydroabietylamine (77). It is indicated for use on hard or soft cordage fibres or on light and heavy duty fabrics at concentrations equivalent to 0.1-0.3% zinc.

Non-metallic organics: Two compounds of this type have become widely appreciated in recent years as fabric proofing agents. These are pentachlorophenyl-laurate and 2,2'dihydroxy 5,5'dichlorodiphenylmethane.

Pentachlorophenyl laurate (lauryl pentachlorophenol, PCP-laurate) was developed to overcome the excessive volatility and susceptibility to leaching of its parent compound, pentachlorphenol, yet retaining its proofing ability.

PCP-laurate is formulated industrially in the U.K. under the trade name of "Mystox". (21). The technical material is an oily brown liquid (Sp. gr. 1.25), odourless non volatile and non-toxic to humans. It is free from deleterious effect on rubber, plastics, light alloys and metals and is unaffected by curing agents, accelerators and anti-oxidants. The compound is insoluble in water and alcohols and is therefore prepared as an emulsion for application in aqueous media. With non-polar solvents, e.g. white spirit, methyl-ethyl-ketone, carbon tetra-chloride, plasticisers such as dimethyl phthalate and tri-cresyl phosphate, and oils, fats and waxes, it is completely miscible. For tropical proofing it is recommended that 2% w/w active ingredient on dry fabric should be incorporated and 1.7% wt. for general usage; under temperate conditions 1% wt. is adequate. It is indicated for use on all textile materials, piece goods or yarn, consisting of cotton, viscose, cellulose acetate, nylon, flax, jute, hemp, sisal, abaca and wool.

Cationic aqueous emulsions of PCP-laurate are employed in the treatment of cotton and flax yarns. Their fibres possess a slight negative charge which induce the positively charged particles of the preservative substantively on to the fibre (93). PCP-laurate is claimed to protect against insect attack.

2,2'dihydroxy 5,5'dichlorodiphenylmethane (D.D.M., "Dichlorphen" (16), "Preventol G.D." or "G.4") is a white to pale pink powder (mp 178° when pure) with slight phenolic odour, almost insoluble in water, slightly soluble in solvent naphtha and other hydrocarbon fluids and soluble in one part of 95% alcohol or in less than one part of ether. The compound possesses high fungicidal activity coupled with low toxicity to higher organisms, durability (low vapour pressure) and relative fastness to leaching.

It is usually applied during one of the finishing stages using one of the four general methods (q.v.) but may be applied to fibre, sliver, yarn or fabric at other steps of manufacture, i.e., sizing or dyeing. It seems generally to be used as an aqueous emulsion but for some purposes a 40% solution of the mono-sodium salt is available. Concentrations employed are 0.1-0.25% wt. on fabrics in store, 0.5% on fabrics liable to come into contact with damp soil, and 1.33% for proofing under severe exposure conditions.

DDM is reported effective at 1% w/w as a mothproofer and at 2% w/w against carpet beetles and termites (20).

The compounds described above are suitable for the long term protection of fabrics. For shorter periods (i.e. as mildew proofing agents during storage) several chemicals have been enlisted. Pentachlorophenol, usually as the sodium salt (industrially available as "Santobrite") (74) is one of these. The compound is readily soluble in water, almost odourless, non-corrosive to metals, very stable, and toxic to a wide range of micro-organisms. It is applied at 0.05% wt. to fabrics at the finishing stage and may be used to protect size and sized yarns in store at 0.10% wt.

A closely related compound is o-phenyl phenol. This chemical is produced as white, crystalline, free flowing flakes (m.p. 56°C) which are readily soluble in most organic liquids. The sodium salt is very soluble in water and it is possible to obtain long term protection of fabrics, even on exposure, by using a mixture consisting of 1 molar part sodium OPP and 2 parts "Fixanol C" (Cetyl pyridinium bromide). A resultant concentration of 1.12% wt. cetyl pyridinium-o-phenyl phenate on the fabric is acclaimed to function satisfactorily under severe exposure conditions.

Salicylanilide, discovered in 1930 at the Shirley Institute, is a useful mildew proofer. The compound is stable, colourless, odourless and non-poisonous. It is subject to leaching but this can be partly overcome if used in conjunction with an aqueous wax emulsion (B.S.2087: 1954) or with Fixanol C (B.P. 606066). Salicylanilide is marketed industrially as "Shirlan". (48). Paste and powder formulations are available for use in size mixings for the treatment of cotton during weaving or of the whole cloth during storage and shipment abroad. The rates specified are 0.03% powder on yarn, 0.05% on finished cloth and 0.07% on tent cloth (double these concentrations if paste used). An 0.6% solution of the powder in cold methylated spirit or other suitable organic solvent can conveniently be used for the treatment of made-up goods (e.g. tents, yacht sails and leather goods). The chemical is also marketed in an alkaline, water soluble form as Shirlan N.A.

Miscellaneous organics: Mercaptobenzthiazole is similar to salicylanilide in its properties and effectiveness (71). Terpineol hydrate is reported to improve the mechanical properties and resistance of cellulose fibres to water, fire and bacteria (98). Dinitro-alpha-naphthol (0.25%), and dinitro-o-cresol (0.25%) in conjunction with p-nitrophenol (0.25%), have been used for felt proofing (71).

Antimicrobial, quaternary ammonium compounds, e.g. Fungitrol 100 (quaternary ammonium naphthenate) are now being used widely for the treatment of lightweight fabrics (51). They are permanent, effective at low concentrations, of low toxicity to man, and without serious odour. They display sustained activity in both soil burial and pure culture tests.

Application and Formulation

Reference to these functions has already been made. Formulation is to convert the active ingredient into a form suitable for its application at the required concentration. Treatment is frequently by total immersion in a solution or emulsion of the preservative. Typical solvents are ethyl hexoic acid, white spirit, propyl alcohol and solvent naphtha, alone or in combination. It is usual to remove the solvent during the drying stage to avoid "blooming" or crystallisation of the preservative.

Emulsions in general are preferred, being relatively free from the fire and fume hazards involved in solvent processes; also the need for solvent recovery, on economic grounds, is avoided. Emulsions, however, are unlikely to effect the same degree of penetration.

For solid preservatives, i.e. dichlorphen, the use of a fine suspension, assisted by suitable dispersing agents, is suggested. Techniques based on emulsification or fine powder dispersion possess the merit of simplicity and cheapness but care is necessary to ensure that the chemical is uniformly applied and that adequate penetration, particularly of a thick, heavy fabric, can be secured. Better penetration has been obtained by application of preservative in situ using a two stage bath treatment. Whereas the cost of this process might be borne with regard to high grade fabrics it is too high for use on hard fibres (rope and cordage) for the treatment of which the preservative must be capable of being applied in one operation, e.g. in emulsion form at the first Good's machine or by dipping the finished rope in a solution of the preservative (31). It is considered more convenient and economical to apply preservative to hard fibres during the batching process than to the made-up cordage, since a comparable degree of protection is obtained with a lower concentration of preservative. This also ensures good penetration and uniform distribution. Water repellents are frequently added to the bath liquors.

Proofing against insect attack

Work in this field has been mainly on woollen goods, which are particularly susceptible to attack by certain moth and beetle larvae.

Moth damage alone has been assessed between 200-500 million dollars (Mosher) to as high as 1,000 million dollars (Fernald). Damage has been attributed to several species including *Tineola bisselliella*, (common clothes moth), *Tinaea pellionella* (case bearing clothes moth), *Tricophaga tapetzella* (tapestry moth), *Tinaea pallescentella* (large pale clothes moth), *Hofmannophila pseudospretella* (brown house or false clothes moth) and *Endrosis sarcitrella* (white shouldered house moth).

Additional extensive damage is incurred through the attack of various species of beetle larvae, including *Attagenus piceus* (black carpet beetle), *Anthrenus scrophulariae* (common carpet beetle or buffalo moth), *Attagenus pellis* (common furriers beetle), *Anthrenus verbasci* (varied carpet beetle), *Anthrenus pimpinellae* F. (woolly bear), *Anthrenus vorax* (furniture carpet beetle), and *Attagenus japonicus* (Japanese black carpet beetle), a major pest in Japan.

In the U.K., the larvae of *Tineola bisselliella* and *Anthrenus verbasci* are the most serious pests attacking wool. Unlike the moth, *A.verbasci* is not affected by light. The adults are strong fliers and the larvae move freely around in search of food. A comprehensive account of the biology of wool pests and their control has been written by Moncrieff (72).

The earliest attempts to protect textile materials were made using naphthalene, pepper and camphor; these doubtless relied for effect upon a high concentration of vapour being present. Early researches on insect proofing directed against moth attack, emanated from the discovery of Meckbach (1917) that a dyestuff, Martius yellow, possessed mothproofing properties when present on wool at 0.25% w/w. Many more dyestuffs were screened following this discovery without success.

Nevertheless, a systematic programme of research initiated in 1932 by the Geigy Co. (54) culminated in 1938 with the discovery of Mitin, marketed in 1939 as Mitin FF (30). This chemical has been described as a "colourless dyestuff". It is light, fast and washproof and acts as a stomach poison. Similar compounds such as Eulan CN (I. G. Farben) and Lanoc CN (I.C.I. Ltd.) were produced about the same year. Meckbach, following a different line of investigation, found that certain fluorine compounds were effective as mothproofing agents and these became subsequently marketed as "Eulans" by Bayer in Germany where they are still being used for treating articles not required to be resistant to washing.

Following the discovery of the chlorinated hydrocarbon insecticides, the first some twenty years ago, there has been a significant trend in mothproofing technique to utilise these and other organic compounds. Geigy led the way with "Trix W" (an emulsifiable DDT for impregnating woollens) and other DDT formulations (19, 37, 94), and were followed by various competitive substances (43, 69). The treatments lacked permanence through evaporation and repeated washes and launderings.

Ultimately the insecticide dieldrin was developed by Shell as a moth proofing agent. For this purpose the chemical is normally added to the dyebath as a 20% w/v solution in xylene (90). An emulsifying agent is added to ensure miscibility. Requirements are that the bath should be slightly acid, maintained at a temperature of 200-212°F and that the dieldrin should be incorporated at 0.1% wt on the woollen article. Temperature is a prime factor since it causes the fibre to swell which facilitates entry of the dieldrin. After cooling the insecticide is held by the wool and this confers on the proofed article a much higher resistance to washing. Chemical linking of the epoxy group in dieldrin with the amino or carboxyl side chains in the wool has been suggested as the reason for the fastness of this treatment (56, 99).

Dieldrin treated articles appear proof against damage by many of pests of wool including that caused by clothes moth and carpet beetle larvae. The trademark "Si Ro Mothd" has been registered in Australia by C.S.I.R.O. for the dieldrin treatment of wool (22).

Principal Fibres and Selected Proofing Treatments

Reference is made in this section to the characteristics of the more important fibres and examples of appropriate proofing treatments are given.

The suitability of a fibre-bearing crop for commercial development is broadly reckoned in terms of cost and output and few of the 700 or so fibrous plant species have proved suitable. Cotton and jute, well known exceptions, are two of the oldest and most extensively developed for textile purposes. Wool, the principal animal fibre, also has a long history of service to mankind, and the rearing of sheep for use of their wool is one of man's earliest industries.

The applicability of a fibre to production processing is governed by its length and breadth. The fibre length determines its spinnability, and fineness is assessed by the length/breadth ratio. This ratio is about 700:1 for the coarser fibres and as high as 5000:1 for the finest. The fibre strength is a measure of ability to withstand the pressures encountered during wet and dry textile operations and of serviceability, in wear. Toughness, flexibility, extensibility, elasticity, density, lustre, softness and suppleness are other properties relevant to specific textile requirements.

Quantities of primary fibre materials moved annually in world commerce are shown below (82).

Principal Plant Fibres	Source	World Production
Cotton	U.S.A., India, China	12,199,180,000 lbs
Jute	Pakistan, India	3,199,180,000 "
Flax	U.S.S.R., W. Europe	860,340,000 "
Hemp	U.S.S.R., Italy, Balkans	661,800,000 "
Sisal	Brit. E. Africa, Indonesia	452,230,000 "
Henequen	Mexico, Cuba	277,956,000 "
Abaca	Philippines, Central America	260,308,000 "
Coir	India	110,961,000 "

Cotton (Gossypium spp.): Four botanical species and numerous agricultural varieties yield the commercial fibre. Species of an allied genus Hibiscus are produced commercially in limited quantities as okra, rose mallow, rose of sharon and kenaf (17). Botanically, cotton is a seed hair; technologically it is a textile fibre. The properties of the commodity vary widely and are determined by genetic factors inherent in the seed and by climatic and other environmental conditions during crop cultivation.

Long fine cottons produce fine, strong yarns. The short coarse fibres yield warm closely knit apparel (40). Principal cotton fabrics, based on grading and staple length, are print cloth, sheeting, denum, drill, duck, Osnaburg, broadcloth, combed lawn and organdy; others include flannel, Gingham, towelling, corduroy and twill (17). Cotton fabrics wash and launder well. They can be bleached, dyed and printed. They are durable and comfortable to wear.

Proofing: Against microbiological attack several methods are claimed to give good results. Chemical processes for modifying the molecular structure by blocking susceptible centres of attack include acetylation (76), cyanoethylation (87), phosphorylation and the use of formaldehyde. According to Moncrieff (73) the persistence conferred on cotton by acetylation is very great and much more effective (also more costly) than conventional proofing (likewise cyanoethylation). Another method is to coat the fabric with a synthetic resin (60). Good results are claimed for amino plasts such as those based on melamine-formaldehyde and urea-formaldehyde combinations. It is not yet determined whether such coatings modify the structure, or interpose a physical barrier between the fungi (or its enzymes) and the cellulose. Some results indicate that incorporating a fungicide with the resin enhances the effect. Brysson (18) and co-workers report improved rot resistance for cotton (canvas) awnings exposed under sub-tropical conditions, when coated with a U/F resin (6% on dry wt. of fabric.) containing copper-8-hydroxyquinolate (0.18% copper). The resin in the form of a water soluble monomer was applied from an aqueous solution and heat cured for three minutes at 300°F. The fungicide (made water emulsifiable) was dispersed in the resin.

Other American research on fungicidal fabric coatings (4) has disclosed dehydro-abietyl ammonium pentachlorphenate (D.A.A.P.) to be biologically active in vinyl resin base; the compound is not, however, entirely satisfactory, being likely to cause discolouration and tackiness. Compounds, approved by the U.S. Air Force (9) for use on coated fabrics, include, copper hydroxy naphthenate (0.4% metallic copper), 2,2'methylenebis (4-chlorophenol) (1%), dodecyldimethylbenzylammonium cyclopentane (2%). These must be added to both the vinyl coating and the fabric.

Many compounds find expression in conventional rot-proof processing such as DDM, PCP-laurate, and quaternary ammonium-salicylanilide combinations. Recent recommendations in this category by the U.S. Air Force (9) include:-

1. 2,2'methylenebis-(4 chlorophenol) at 1.25 ± 0.25% wt.
2. Copper-8-hydroxyquinoline at 0.15 ± 0.05% wt. (as Cu).
3. Mixtures containing not less than 95% of Zinc dimethyldithiocarbamate with 2 mercaptobenzothiazole as synergist. 1.25 ± 0.25% wt.
4. Dehydroabietylammonium pentachlorophenate (DAAP) 1.25 ± 0.25% wt.

Incidentally, DAAP is suitable for use on natural rubber.

During the treatment of cotton with copper salts in aqueous solution, it has been noticed that preferentially high amounts of ionic copper are absorbed. Hannan (44) showed that the fabric should first be scoured and the copper preservative applied as a water soluble citric acid or glycine complex. Such a mixture can be used to precipitate copper 8 hydroxy-quinolate *in situ* by prior steeping in aqueous acetic acid containing 8-hydroxyquinoline. Polyoxyethylene - thioether (0.05%) is the preferred wetter.

It is claimed that the proofing effected by copper-8-hydroxyquinolate, applied in oil or o/w emulsion to cotton fabric, can be appreciably enhanced in conjunction with an organo-mercury compound (USP 2,698,263).

The effectiveness of various preservatives to overcome actinic damage on proofed cotton (calico) fabrics exposed at sunny sites in West Africa is compared in a Ministry of Supply report (29). Proofings were carried out with copper 8 hydroxyquinolate, DDM, metallic naphthenates, cuprammonium, PCP laurate and chromium compounds. Best all round results were obtained with copper 8 hydroxyquinolate (formulated with a water repellent agent) and copper/iron. Chromium compounds afforded some protection against actinic breakdown but imparted no resistance to microbiological attack. Several of the samples treated with effective proofing agents deteriorated more rapidly, in the sunlight, than the untreated control.

Jute: Reference to jute appears in Indian writings as early as 800 B.C. The fibre is obtained from two species of Corchorus mainly cultivated in India and Pakistan. Other species, such as Hibiscus grown in Java, China and the Congo, are useful substitutes. It is a cheap, coarse fibre, which after conversion into yarn, yields fabrics for bagging or wrapping (Hessian and Burlap) and sacking (a heavier material). It is an important cordage fibre. Structurally, jute consists of lignin (12-14%) and holocellulose, or total polysaccharide, (82-85%), the latter made up of alpha-cellulose (58-63%) and hemi-cellulose (21-24%). The hemi-cellulose fraction, shown to be most vulnerable to micro-organismal attack, increases the overall susceptibility of the fibre (12).

Chemical modification of the fibre, e.g. by acetylation or cyanoethylation substantially improves its ability to withstand attack and the altered fibre is resistant to leaching (14). Such processes are, however, uneconomical and the conventional procedure is to apply a rot proofing chemical. For general effectiveness and permanence Bell lists as jute preservatives:-

> copper naphthenate, cuprammonium, ammoniacal copper, copper/iron, copper/chrome and copper-8-hydroxyquinolate. The compounds DDM and PCP-laurate are classed as moderately successful; zinc sulphate, mineral khaki, chrome tinting and salicylanilide as unsatisfactory. Copper naphthenate gave the best results in sea exposure tests. A sample of cloth treated with this compound (at

0.76% Cu) retained 42% cloth strength after 4 months' exposure; an untreated sample was completely destroyed in 3 months.

The protection of jute with a copper preservative is a widely established practice. Copper salts are readily absorbed in appreciable quantities and not so readily leached, even in soil burial tests; during the course of weathering however, they are generally found to have a detrimental effect upon the fabric strength, because of their catalytic action in the presence of sunlight.

Cutch-cuprammonium treatments have been developed over a long period for use in India. These should be applied at a strength equivalent to 2%, or less, metallic copper to give approximately 1% by wt. copper on the dry, proofed fabric. (Strength loss is approximately 10-15%). In circumstances not precluded by taint, copper naphthenate, in aqueous emulsion or preferably, organic solvent, yields a satisfactory rot-proofing finish at 0.8 to 1.0% wt. metallic copper on the dry fabric. A solution of copper naphthenate in creosote is even more effective; tendency to leach is retarded by the water repelling action of the creosote (20). Copper-8 and cupferron are newer compounds of considerable promise but somewhat expensive.

The protection of jute fabrics in store in India has been discussed by Roy (86). Requirements are that the fabrics should, after proofing, be placed in cool, dry, well-ventilated rooms. Proofing was by steeping in white spirit containing zinc and copper soaps of oleic and naphthenic acids, excess solute afterwards being squeezed out and the treated fabrics dried slowly. Uptake of chemical, based on the work of Elkin and White, was in amount equivalent to 0.25% metallic copper and 0.5% zinc. Sodium salicylanilide (Shirlan) was used for mildew-proofing and because of the combustibility of jute a fire-proofing treatment, e.g. aluminium oxide, barium carbonate, or ferric oxide was applied before storage.

Pingale and Majunder (78) have reported on the use of insecticides to impregnate jute bags employed in food storage. Of the compounds tested, lindane (up to 35 mg/sq. ft) was particularly effective with several commodities tested. The use of DDT, aldrin and dieldrin resulted in contamination at effective concentrations. Dieldrin 50%/ lindane 50% at 70 mg/sq. ft/ gave adequate protection over one year.

The conditions under which pyrethrins/piperonyl butoxide treated sacks are effective have been noted by Bell (15).

Flax: The flax plant, Linum usitatissimum, yields linseed oil and linen fibre. It is grown chiefly in the U.S.S.R. and in Western

Europe. It yields fine yarns for use in weaving high quality linen fabrics, and coarse yarns for rougher fabrics, twine cord or rope. Linen fabrics are smooth, possess high strength and considerable resistance to tearing (especially when wet) and have a permanent natural lustre. Since it is the strongest of natural fibres and because it swells when wet, it is well suited to the manufacture of tarpaulins, for which purpose it is usually treated with a water proofing agent based on silicone, fireproofed, and rot-proofed with a chemical, such as PCP-laurate. It is recommended that the yarn should be boiled to discharge impurities and to render the canvas more able to absorb and retain the proofing agent (5).

Hemp: There is only one species of true hemp, Cannabis sativa. It was one of the earliest fibre crops used by man and is widely grown in the U.S.S.R. and China. In Asia and Europe hemp fibre has provided a range of textile products from fine fabrics to coarse ropes. The cannabis drug (marijuana) is a side product obtainable from its leaves.

Sisal: Sisal (53) is classified as a hard fibre and is obtainable from the leaves of Agave spp. A.sisalana Perrine, native of Central America and Southern Mexico is the "true sisal" fibre, and has been introduced to Java, Sumatra, Haiti, East and West Africa and India. In East Africa it is the only species of commercial value. Other cultivated species are A.cantala Roxb (its fibre is known as "Maguey" in the Philippines and "Aloe" in India), and A.fourcroydes Lemaire which yields the "henequen" of commerce and which is grown almost extensively in Mexico and Cuba.

A fourth species of interest A.amaniensis Trelease and Nowell, or blue sisal, was found growing under bush at the East African Agricultural Research Station, Amani. The first plot was planted at the end of 1929. Hopes for its wider cultivation had to be abandoned because of its susceptibility to bole-rot and weevil damage, (Scyphophorus acupunctatus Gyll) but it usefully served hybridization (57).

Sisal fibres are very strong, also harder but less flexible than "Manila hemp" (abaca) which they nearly match in tensile strength. Binder twines, ropes, carpets, sacking and mats are produced from this fibre. Copper naphthenate significantly improves the resistance of sisal rope to soil burial and weathering (70).

Abaca: A description of this fibre and the extension of its cultivation to the Commonwealth has been given by A. E. Haarer (41).

The fibre is obtainable from the stems of the abaca plant, *Musa textilis*, which is widely cultivated in the Philippines, and latterly in Central America.

It is an important cordage fibre, especially for marine cordage, since it displays great elasticity, hence strength in the heavier ropes. It is also light and soft to handle and does not swell a appreciably in water. In the U.S.A. where it is known commercially as "Manila hemp" or "manila" it has become the premier cordage fibre (82).

Coir: The outer covering of the husk of nuts of the coconut palm, *Cocos nucifera*, cultivated mainly in India and Ceylon. The fibre obtained from the fully ripened nut is superior to that of the unripe or tender fruit for both tensile strength and colour. The best quality coir is made from the husks of mature nuts harvested whilst still green; if required for making bristles the nuts are dried. It is estimated that the husk of 600 coconuts will yield one hundredweight of good quality fibre (79).

Coir yarn is elastic and will withstand the prolonged action of sea water, and is used in tropical Asia and the South Seas for hawsers, cables and small cordage (39). Yarn of uniform twist, soft texture and good colour is converted into mats, mattings, rugs and carpets.

It is one of the most resistant natural fibres to fungal and bacterial attack.

Fibres of Animal Origin

Wool: The importance of this commodity can be adjudged from the total world production of raw wool, which has been estimated (10) for 1956-57 at over 5,000 million lbs, (one sixth produced by the Soviet bloc). (10).

Wool fibres are stronger than cotton but less so than linen or silk. Their ultimate employment is determined by such factors as collective length, fineness, strength, colour, soundness, uniformity and trueness to type of an aggregate of fibres. Length and fineness are first to receive attention when selecting "apparel" wools. Woollen fabric prepared from these is known as "worsted". The cloth is round and smooth and the weave is clearly visible. It consists of long fibres, of fine quality, woven parallel to one another. Such cloth is used for men's suiting and for knitted fabrics.

In contrast woollen fabrics of the coarser type (dry, hairy and of short staple, of thick fuzzy appearance) are classed as carpet wools. These are chiefly used for making blankets, floor rugs and carpets. Most of the wool produced in India and Pakistan is of this type.

Woollen textiles possess a high thermal insulation capacity (warmth evoking), durability, crease resistance and a high degree of elasticity or "resilience". Resilience is determined by the degree and evenness of waviness or "crimp" of the fibre. Too frequent washing may cause the fabric to lose its elasticity and to shrink.

Lanolin is the processed natural grease of the wool fibre, removed before the yarn is spun, and constitutes a useful by-product for hand and barrier creams, etc.

Susceptibility to attack: Wool is easily damaged by weak alkali but unlike the cellulose fibres, is acid resistant. It is subject to insect and fungal attack; by chemical modification of wool, e.g. reduction of the disulphide linkage in the wool keratin followed by treatment with an aliphatic dihalide, the wool can be rendered immune to moth and enzyme attack (65). This is more costly than conventional treatment with a proofing agent. The problem of insect attack has already been discussed and remarks below concern proofing against mildew.

Moisture acts as the chief factor in the growth of mildew on wool, about 24% being critical on scoured wool at 23°C; if unscoured the moisture content is lower (6). Chemicals for the inhibition of mould growth on wool in service include 1% chrome as CrO_3 or Cr_2O_3; (preferably with copper 0.5-1.0%), sodium fluoride (0.5%) or sodium silicofluoride (0.5%). Protection from mould attack during processing is afforded by lauryl PCP (0.5%) sodium salicylanilide (0.1%), and sodium-PCP (0.1%). Zahn has shown that wool can be made permanently resistant to attack by bacteria and fungi by chemical alteration with quinone, 1-fluoro-2: 4 dinitrophenol or 1-chloro-2: 4-dinitrophenol (3).

Silk: A protein fibre produced by the labial spinning glands of the larvae of Bombyx mori, Linné (91). The main core consists of fibroin (70-75%) a tough elastic protein which is covered with gelatinous sericin (20-25%). This assists its processing. It is recognised as the toughest of natural fibres characterised by high strength, elasticity, fine resilience and good heat of wetting (which yields a feeling of warmth). Silk is more resistant than wool to enzymatic attack and also the action of bacteria. It may be attacked by certain dermestid beetle larvae.

The quantity of raw silk produced in 1939 was estimated at 50-70 million lbs, equivalent to over a million million cocoons (68).

Mohair: A long fleece-like hair from the Angora goat, Capra mirius. The name also applies to the fibre obtained from crossbred animals. Mohair weft mixed with cotton warp is known as mohair lustre and is plain or figured cloth suitable for dresses.

Insect Repellents

The quest for substances, which applied to clothing or the skin of man and animals, could repel disease carrying blood-sucking and other noisome pests has continued over many years.

It is estimated that over 20,000 compounds of synthetic origin have been screened, mostly in the U.S.A., since the days when oil of citronella was the standard material for this purpose, the object being to find compounds with good residual effect, pleasing odour and without harmful properties. In general, repellents that have been found effective for skin application are suitable for application to textile fabrics except certain synthetic fibres, e.g. rayon, acetate and dynel fabrics.

At the present time, two highly efficient compounds are recommended for clothing application. These are diethyltoluamide (D.E.T.) and butylethylpropanediol (106).

Diethyltoluamide (containing at least 70% meta isomer, which is the most active) has been found highly effective against many species of mosquito, fleas, mites, ticks, biting gnats and various flies. It is longer lasting in its effectiveness on clothing than any other repellent tested, having proved active against various insect species for several days.

The other, butylethylpropanediol, is a constituent of M-1960, the U.S. Army standard all-purpose clothing repellent. M-1960 consists of

butylethylpropanediol	- 30%
butylacetanilide	- 30%
benzyl benzoate	- 30%
emulsifier	- 10%

Clothing is treated by dipping in a 5% water emulsion of this mixture.

M-1960 is effective against mosquitoes, black flies and various other insects. It is, unlike D.E.T., not suitable for skin application.

Clothing treatments should always be supplemented with skin applications using a suitable repellent e.g. D.E.T., chlorodiethylbenzamide, ethyl-hexanediol, dimethyl phthalate, dimethyl carbate or indalone.

TYPICAL SPECIFICATIONS

Specification	Authority	Subject	Indication
British Standard 2087:1954	British Standards Institution	Chemical requirements for textiles	Details are given of eleven established processes used by the Services for preserving textiles, and of methods of analysis for fabrics thus treated.
UK/AID/920/1	Ministry of Supply, Aeronautical Inspection Directorate	Manila rope and lash line for mountain climbing.	"Mystox L" (PCP laurate) or other recognised processes not relying on tars, creosotes or copper.
UK/AID/623/4		Specification for canvas, rot-proof green.	Zinc naphthenate, chrome tinting or PCP-laurate.
UK/DIS/2114 A	Ministry of Supply Directorate of Stores	Heavy flax, hemp and cotton fabrics.	Copper naphthenate, Cuprammonium and PCP-laurate treatments.
Aircraft Material Specifications DTD Series DTD 5505	Ministry of Supply	Cotton webbing - single-ply.	Mineral khaki or PCP-laurate.
Defence Specifications DEF Series DEF-1119	Ministry of Defence	Netting, mosquito, cotton.	PCP-laurate or other approved agent.
DEF 1055 A		Clothes, flax, single-end, plain.	Salicylanilide or PCP-laurate.

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REPORT OF THE GOVERNMENT CHEMIST
YEAR ENDING 31st MARCH 1958. H.M.S.O.

Insecticidal Residues in Foodstuffs

The separation of very small quantities of pesticide residues from fatty materials is often a difficult operation and work is in progress to improve analytical methods. In this connection, and for use with acid resisting insecticides such as DDT and benzene hexachloride, a useful modification of the technique of preliminary treatment with sulphuric acid has been developed. This modification enables comparatively large amounts of oil or fat to be treated.

The general method of total organic chlorine determination, as described in previous Reports, has been used in the examination of a variety of treated crop samples, mainly taken during the course of field trials of insecticides by the National Agricultural Advisory Service. For example, blackcurrants sprayed with endrin and sampled subsequently at intervals were shown to have a residue of endrin which generally declined to insignificance by the time the crop was fully mature. Residues of dieldrin in beetroot and carrots grown in soil treated with this insecticide were also found to be negligible. Where, as in some of these examples, the level of the residue sought is no more than 0.1 parts per million, the limitations of the organic chlorine method become apparent, but even here results of some utility may be obtained provided untreated control material is available, and as many samples as possible, each as large as can be conveniently dealt with, are taken for analysis.

Considerable progress has been made in the separation of the sulphoxide and the sulphone derived from meta-systox, from the naturally occurring phosphorus compounds in plant material. In this connection Brussels sprouts were a particularly difficult case. A method has now been worked out which is capable of being applied to most vegetables. This has been tried out on a field crop of cabbages from the time of spraying to the time when the residue was of the order of 0.1 parts per million. Investigations are in progress on the leaves of a treated potato crop and this will ultimately extend to an examination of the tubers. Basic work on potato tubers has already been done. Further work on lettuces in the field is contemplated.

Mercury Pesticides

On behalf of the Ministry of Agriculture, Fisheries and Food, a report has been drawn up with detailed instructions for the determination of residual mercury in apples after treatment with mercury pesticides. Over two hundred estimations have been carried out on apples of various species which had been treated with ten inorganic and organic mercury compounds. The results of these estimations have been examined with a view to ascertaining the limits of accuracy of the method, the nature of the errors inherent in the method, and the range of "blank" values due both to reagents and to different species and origin of the apple samples. The determination of the volatility of about 17 organomercurials by static and dynamic methods is being continued.

Analyses have been undertaken in collaboration with Long Ashton Research Station and other Divisions of the Department in the estimation of mercury in apples and foliage sprayed with phenyl mercuric nitrate. The results have provided useful information on the persistence of spray residues as the samples were collected over a period of months.

Pesticide Residues

There is a large and growing class of pesticide residues which either because of changes they undergo in the plant, or intrinsic difficulty of analysis, cannot at present be accurately determined by purely chemical means. In such cases attempts have been made elsewhere with some success to use insects for a biological assay. We have started to investigate a group of methods, somewhat more selective than the insect feeding ones, but fundamentally similar in that they depend on the inactivation of enzyme systems by the pesticide residues. Such methods, some of which have been published, seem to offer the possibility of testing in one operation for residues of all the anticholinesterase group of pesticides. Their use could help in some measure to allay the anxiety which is sometimes expressed regarding the lack of sufficient public control of pesticide residues in food crops.

Sheep Dips

This Department has, for over half a century, been responsible for the analysis of sheep dips approved by the Ministry of Agriculture, for use under a succession of Sheep Scab Orders culminating in the Sheep Scab (Amendment) Order of 1948. This last order recognises the existence of a type of dip containing the gamma isomer of benzene hexachloride. The use of this type of dip has, we understand, been attended by almost complete success in the elimination of scab from the sheep of this country. We have now had considerable experience in the analysis of this type of dip. Benzene hexachloride may be separated from mixtures with most other substances by treatment with fuming sulphuric acid on a kieselguhr column. An account of a method employing this device with subsequent use of another column for the separation of the gamma isomer is to be published. It has been found possible to substitute with advantage an easily obtainable precipitated silica for an imported American silica gel of somewhat unpredictable behaviour.

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE (IN GREAT BRITAIN)

Recommendations, for the safe use in agriculture and horticulture of the compounds noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Demeton-methyl (a mixture of demeton-O-methyl (2-ethylthioethyl dimethyl phosphorothionate) and demeton-S-methyl (S-2-ethylthioethyl dimethyl phosphorothiolate).
Revised January, 1959.

Phosdrin (2-methoxycarbonyl-1-methylvinyl dimethyl phosphate).
Revised March, 1959.

Rogor (OO-dimethyl S-(N-methylcarbamoylmethyl) phosphorothiolothionate.
Revised February, 1959.

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park, London, N.W.1.

WORLD HEALTH ORGANIZATION NEWS

Insecticide Resistance in Malaria Vectors

WHO is now publishing from time to time, in its "Weekly Epidemiological Record", information received in respect of confirmed cases of resistance of natural vectors of malaria to chlorinated hydrocarbon insecticides. It is hoped that this information will enable health administrations to take active measures to prevent the spread of the resistant vectors.

(Chronicle of the W.H.O., 1958, 12, (12), 402.)

AGRICULTURAL RESEARCH IN THE U.S.A.

1. Insects and Ecosystems

Studies are being made to learn more about the complex of related factors forming ecosystems. These factors, which may be density independent (climate and insecticide) or density-dependent (parasites, predators, competition for space and food resources), are being studied individually and combined.

The effect of climate on the Mexican fruit fly has been studied in bioclimatic cabinets simulating the different temperatures and humidities of various localities in the United States. These experiments indicate that a permanent population of the fruit fly could develop only in coastal areas of southern California and the Gulf of Mexico, and most of Florida. The climatic requirements of other insects and mites are to be studied. Results could influence eradication programs and be a basis for establishing trapping dates. Some States could eliminate detection systems if they knew the insect would not become established under the local climatic pattern.

Wooden blocks, each containing a hole 6" long and 3/16-1/2" diameter are being used as traps to study the life histories of wood-nesting wasps that paralyze prey by stinging. The combination of factors comprising an insect's entire ecosystem is being studied on tobacco pests. One of these, the green peach aphid is affected by a large number of factors but only eight variables are of any measurable significance: temperature, rainfall, 4 host plants (tobacco, turnips, collards and wild mustard), and 2 diseases (a fungus and an unidentified condition that develops in hot weather, sometimes referred to as the hot-weather disease).

Experiments indicated that aphid populations were chiefly destroyed by biological factors, but biological changes reflected changes in the weather. Aphid numbers increased in fall, when host plants were in good condition and temperatures were favourable. But in the winter, when cool weather slowed aphid reproduction, and high humidity and wet soil favoured fungus, aphids decreased. Further decline occurred when extreme low temperatures damaged host plants, but aphids were not killed directly by temperature. In the spring, when temperatures were higher and the weather was dry, aphids increased in tobacco - until the hot-weather disease again reduced their numbers. Insects competing with aphids for food, many parasites and predators, and alternate hosts of the two main diseases are not significant.

Study of the interrelationships in ecosystems is useful for improving control measures, for example, aphid infestations in tobacco plant beds can be prevented by controlling nearby patches of winter host plants.

(Agricultural Research, 1958, 7, (6), 3-5.)

2. Peach Tree Borer (*Sanninoidea exitiosa*) on Apricots

Standard control treatments are soil fumigation, directed against the overwintering larvae and monthly treatment, in the foliage season (May-August), with DDT as a trunk spray which prevents reinfestation by either killing moths attempting to deposit eggs, or killing young larvae on hatching. Both these methods give only partial control.

In trials carried out in 1957 and 1958 sprays were applied to the trunks of the trees from the main crotch to soil level. The first treatments were made in May when the presence of pupal cases and cocoons indicated adult emergence. Subsequent sprays were applied at approximately monthly or bi-monthly intervals. An average of 1.5 gallons of spray were applied to each tree and the trunks were wet to the point of run-off.

Evaluation of results was based on counts made in September of the number of frass spots (strikes) which were associated with individual borers. Further evaluation of the 1957 treatments was made in the following season by counting the numbers of pupal cases and larval cocoons remaining on the surface of the ground or sticking out of the tree after moths had emerged.

The 1957 treatments were (per 100 gallons): 8 lb. DDT 50% W.P., with or without a sticker, applied monthly or bi-monthly; ½ gallon endrin 19.2% (w/w) E.C. applied monthly; 8 lb. Thiodan 25% W.P. applied monthly; and also a single application of whitewash. Results showed that both Thiodan and endrin were very promising for peach tree borer control. There was little difference between the various DDT plots, as all gave what could be considered commercial control, but were not as good as either the Thiodan or the endrin plots. Whitewash did not seem to be an effective means of preventing borer attack.

The 1958 treatments were (per 100 gallons): 1 gallon Thiodan 21% (w/w) E.C. applied monthly and bi-monthly; ½ gallon endrin 19.2% (w/w) E.C. applied monthly and bi-monthly; 8 lb. Guthion 25% W.P. applied monthly and bi-monthly; one application of 1 gallon dieldrin 18% (w/w) E.C.; and 8 lb. DDT 50% W.P. applied monthly. Results showed that

Thiodan and endrin at both monthly and bi-monthly intervals gave excellent control of the peach tree borer. Guthion was effective when applied at monthly intervals, but less so at bi-monthly intervals. The DDT treatments resulted in an average of one borer per tree, which can be considered commercial control. The single spray of dieldrin, although reducing the number of borers below that of the check, does not seem to be a feasible method of control.

(H.F. Madsen and R.R. Sanborn. California Agric., 1959, 13, (1), 10-11.)

3. Transmission of Virus by Nematode

For the first time, a nematode has been proved a carried of plant viruses. In recent experiments a "dagger" nematode, Xiphinema index, transmitted fanleaf virus of grapevine from infected to healthy plants. In one experiment, healthy grapevines and fanleaf-diseased vines were planted in the same clay pot. The healthy vines - infested with this dagger nematode (from the root zone of disease-free grapevines) - developed fanleaf in 10 months. In another study, similar results were obtained using dagger nematodes from a fig tree's root zone. All control vines remained healthy.

This discovery suggests that control of this nematode in vineyards will prevent spread of the virus. Although no satisfactory method has been found for controlling the nematodes around the roots of living grapevines, it is possible to control soil nematodes before new vineyards are planted or before replanting.

(Agric. Research, 1959, 7, (7), 14.)

4. Control of Drywood Termites

Control of the drywood termite has been obtained by one or the other of two methods. When infestations are accessible, and reasonably localized, the drill-and-treat method can be used. This involves the injection of insecticide dusts or liquid fumigants into the galleries. For more extensive or inaccessible infestations, the entire building may be fumigated with methyl bromide gas. An emulsion of 10% pentachlorophenol in a light oil (Woodtreat TC) used to prevent damage to a building's substructure by subterranean termites may be used for actual eradication of drywood termites, because the termite colony is confined in a limited area within the wood. As the emulsion breaks, the toxic oil is slowly released and penetrates deeply into the wood. Penetration is aided by the fact that the termites tend to burrow as close to the surface as possible without actually breaking through to the outside leaving only a very thin layer of wood.

Reinfestation, even within a year after treatment, is not uncommon. Therefore, a preventive treatment, applied in conjunction with, or immediately after the control treatment, has been needed. Certain inert dust diluents, particularly some sorptive clays, were observed to be more effective than existing formulations of insecticide dusts. One of these, Olancha clay, was registered as a termite preventive under the name of Olancha Tox, and applied in attics at the rate of 5 lb./1000 sq.ft. Further research showed that silica aerogels killed termites more rapidly than clay dusts even at a much lower dosage. Silica aerogels have been used primarily as flatting agents in the paint industry. For certain industrial reasons it is desirable to impregnate them with small percentages of certain inorganic fluorides. It happens that the fluorides have the effect of giving them a positive charge, thus increasing their depositing properties. In addition, insecticidal effectiveness has been increased greatly by the monomolecular layer of fluoride. The fluorides do not detract from the ability of the silica aerogel particles to adsorb wax. The water-soluble flurides are thus brought into contact with water-containing tissues in which they can be dissolved and exert their toxic effect.

A fluoride-impregnated silica aerogel (Dri-Die 67) at 1-2 lb./1000 sq.ft. was shown to be superior to Olancha Tox at 6.4 lb. and chlordane at 2-4 lb./1000 sq.ft. For example, knowckdown and mortality figures (in hours) for Dri-Die 67 and chlordane at 2 and 4 lb./1000 sq.ft. respectively were:

	Day after treatment		35 days after treatment	
	Knockdown	Mortality	Knockdown	Mortality
Dri-Die 67	1.7	4.7	1.9	3.9
Chlordane	8.5	24.0	24.3	33.3

In other experiments, Dri-Die 67 was effective also in the control of German, oriental, and brown-banded cockroaches. In addition, it shows promise in the control of fleas on pets, two-spotted mites on roses, and of bees and wasps colonizing in attics and walls of houses.

(W. Ebeling and R.E. Wagner. California Agric., 1959, 13, (1), 7-9.)

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA - QUEENSLAND

Vermin Destruction (dingoes, foxes, eagle hawks, wild pigs, hares): An aerial poisoning campaign was carried out in the Lake Eyre region of South Australia, where 300,000 baits were distributed, and in the cattle lands west and east of the main sheep area of Queensland where 642,000 and 248,000 baits were distributed respectively. The campaign for inoculation of rabbits with myxoma virus and subsequent release in the field continued. A dingo-proof barrier fence, 3,500 miles in length is being established to include 135,000,000 acres of sheep land and potential sheep land at present depasturing approximately 19,000,000 sheep and 600,000 cattle.

(Annual Report of the Land Administration Board on the Operations of the Department of Public Lands and the Superintendent of Stock Routes for the Year 1957-58.)

AUSTRALIA - WESTERN

Control of Red Spider, Tetranychus telarius (L.): A fully replicated experiment was laid out using Westralia beans as the host plants. The following materials and concentrations were used:-

Metasystox - 1 pint per 125 gallons.
Diazinon - 4 pints per 100 gallons.
Trithion - 1 lb. per 100 gallons.
Parathion 20% - 1 pint per 100 gallons.
Mitox - 2 lb. per 100 gallons.
Phosdrin - 28 oz. per 100 gallons.
Malathion + Ovobane - 25 oz. malathion 50%, 1 lb. Ovobane, per 100 gallons.
Parathion + Shellamite - 1 pint parathion 20%, 1 lb. Shellamite, per 100 gallons.
Aramite 10% P.C.P.P.C.B.S. 5% - 4 lb. per 100 gallons.

The statistical analysis of the experiment showed Metasystox, Trithion, and diazinon to be vastly superior to the other materials tested. These three materials were further tested on commercial crops with excellent results.

In view of the information yielded by the bean experiments, trials were also conducted into the control of red spider on apple trees. Metasystox, Trithion and diazinon were applied with a Turbomist machine in a commercial orchard. This resulted in a very satisfactory control of red spider, whereas trees similarly treated with malathion were heavily infested. Further work is planned for the coming season to fully evaluate these materials and to test other recently released miticides.

References

Jenkins, C.F.H. (1955). Insect Pests and Their Control. The Red Spider, Tetranychus telarius (L.), J.Agric., W.Aust., 4, (3), 2; 145-150.

(Preliminary Report of Experiments by G.D. Rimes (Entomologist). J.Agric.Western Australia, 1958, 7, (6), 619-620.)

Tomato- Bacterial Canker: The disease is caused by a bacterial parasite *Corynebacterium michiganense* carried by infected seed or seedlings, and possibly by insects. Once established it is very difficult to control and can persist in the soil or on supporting stakes from season to season. It first appeared in Western Australia in December 1945 on seed of the Tatura variety introduced from the Western States, and has since become very widespread. Disease symptoms, its development and control measures are discussed.

(W.P.Cass Smith, Olga M.Goss. J.Agric.Western Australia, 1958, 7, (6), 625-632).

Celery Leaf Spot:

Leaf spot or late blight of celery is incited by the fungus *Septoria apii* Chester and was first recorded in Western Australia at Osborne Park in 1923. Investigations commenced during the past autumn have indicated that Bordeaux 4:4:40 is the most effective of eight fungicidal preparations tested as cover sprays for the control of celery leaf spot.

Effect of Various Cover Sprays on Incidence of *S.apii*

Fungicide	Evaluation of Leaf Spot Incidence	
	Mean Leaf Value	$\sqrt{X}$
Bordeaux	0.07	0.23
Phygon	0.10	0.29
Ziram	0.16	0.39
Zineb	0.27	0.51
Captan	0.30	0.55
Thiram	0.34	0.58
Vancide	0.63	0.79
Ferbam	0.74	0.85
Control (no fungicide)	2.51	1.58
Difference for Significance		
5% level		0.16
1% level		0.22

(S.C.Chambers. J.Agric.Western Australia, 1958, 7, (6), 632-634.)

Potato - Root-Knot Eelworm: A short account of the symptoms, life history of the pest, its transmission and control.

(Olga M. Goss. J. Agric. Western Australia, 1958, 7, (6), 638-640.)

CANADA

Insect Pests of Livestock and Man

Black Flies: A 'simulated animal' trap was developed that appears to attract adult black flies in a manner similar to that of their normal hosts. The trap proved useful for estimating populations of the chief cattle-infesting black fly in Saskatchewan. The dosage of DDT required to control the larvae of this species was reassessed. As a result the dosage was doubled in the annual treatment of the Saskatchewan River, the principal source of the insect. Very satisfactory control was obtained.

Effects of Sound on Mosquitoes: Laboratory investigations showed that male mosquitoes can be attracted to traps more readily by certain artificially produced sounds than by recordings of the sounds produced by their females. Females of different species were found to produce different sounds, and larvae were killed rapidly by applying ultrasonics to the water in which they lived.

Warble Flies: The first test in Candada of a systemic insecticide (the organic phosphate Dow ET-57) against cattle grubs, the larvae of warble flies, was completed. Over 250 head of cattle were used in the tests; single oral applications at 100 mg per kg gave up to 98.5 per cent reduction when given before the larvae reached the hypodermal stage. The material was not effective after the grubs had encysted in the backs. The best time for treatment is therefore the late fall or early winter. None of the animals showed any serious toxic symptoms. At 10 mg per kg daily in the feed for 18 days, the insecticide gave equally satisfactory results. Dow ET-57 was registered under the name Trolene and was widely used in 1957-58.

Insect Pathology

Field studies were restricted to continuation of observations on the effects of virus introductions. One small test was carried out to assess the value of virus disease in the control of the red-headed pine sawfly. While control was obtained under the conditions of the test, it is not yet clear whether the virus is virulent enough to replace chemicals. Plans to begin tests on control of Swaine's sawfly had to be postponed when it was found that the available virus was of very low virulence.

It was found that there seems to be some sort of protective effect in spruce budworm infected with granulosis virus; in the case of later infection by polyhedrosis virus the latter is inhibited to a greater or lesser extent. It was hoped that the two diseases together might have been additive in their effect.

Studies of the toxin-producing bacteria were continued. Techniques for studying the mode of action of the toxin were developed and it appeared that the toxic effect was exerted in the mid-gut. Toxicity tests were continued and showed that these organisms will cause death in more than 50 species of insects, mostly lepidopterous larvae.

Serological methods proved to be very useful, both in assessing relationships between organisms and in diagnosing disease in early stages of infection. It was found possible to demonstrate the presence of the organism in an insect four days after infection - much earlier than by any other technique.

Agricultural pests and diseases

Wheat: Fungicides in which nickel is the active component were highly effective against rust, particularly in arresting the growth of infections that had occurred during a period of 5 or 6 days before the fungicide was applied. Two applications, about 10 days apart, gave satisfactory control of rust. Three derivatives of cycloheximide were tested and found to become systemically active in wheat. All three derivatives caused significant reductions of stem rust infection when applied as sprays in the field.

Agropyron streak mosaic was identified for the first time in Canada when it was recognized on couch grass at several locations in Ontario. It was also identified on wheat and a number of wheat - grass hybrids at Ottawa. The causal virus was transmitted experimentally by eriophyid mites from diseased wheat, as well as by manual methods of inoculation.

In Manitoba the wheat midge was reported only from the Red River Valley where an average of 52 per cent of the heads and 6 per cent of the kernels were infested. Preliminary tests indicated that demeton applied just before the larvae begin feeding controls this pest. Malathion and lindane were ineffective.

Corn: Infestations of the European corn borer in south-western Ontario were much less severe than in 1956. Granulated Dylox, endrin, and heptachlor each applied in three applications beginning when larval feeding on leaves was conspicuous gave highly satisfactory control of the borer in sweet corn. Emulsible DDT and granulated DDT were somewhat less effective.

Alfalfa: Malathion applied in September and Toxaphene and methoxychlor applied just after hatching in the spring each almost eliminated the meadow spittlebug on alfalfa in southwestern Ontario. Heptachlor applied in the fall and in the spring reduced the numbers 75 and 85 per cent respectively.

Potatoes: Late Blight. The fungicide trials in 1957 were conducted under weather conditions ideal for the development of late blight. Of the materials compared with Bordeaux 8-4-80 and maneb, an experimental mixture of maneb and a fixed copper was moderately effective against foliage blight, and plots sprayed with the mixture produced the top yields of marketable No. 1 tubers. Yields in bushels per acre were:- experimental mixture 414.0, maneb 408.5, Bordeaux 382.4, and unsprayed 231.4.

Black Leg. Several seed treatment chemicals were tested at Charlottetown P.E.I., for controlling black leg in Sebago. All seed pieces were cut and inoculated with a suspension of the black-leg organism before treatment. Dry and water-dipped checks developed 40 per cent black leg; captan and chloranil were ineffective in controlling the disease but acid mercuric chloride and Semesan Bel gave satisfactory control. Treatment with a combination of Semesan Bel and Agristrep (streptomycin) resulted in the least amount of black leg; 2.7 per cent of the plants were affected.

In other trials designed to control Verticillium wilt, black leg occurred quite consistently throughout the plots. Under these conditions the chemical seed treatments (dichlone, zineb, captan and chloranil) were quite ineffective in reducing black leg; 17 to 37 per cent of the plants were infected. But where seed was treated with Semesan Bel, black leg infection never exceeded 1 per cent.

Bacterial Ring Rot: Among the various seed-piece disinfectants tested for ring-rot control, the acidulated bichloride of mercury was the best. The treatment consisted of dipping potato sets for 10 minutes in a solution containing 6 ounces of mercuric chloride in 25 gallons of water to which 1 quart of hydrochloric acid (31 per cent) was added.

The use of small tubers for seed instead of large tubers cut into sets may be recommended as the most effective and possibly the most economical means of eliminating or checking the dissemination of ring rot on a farm or in a potato growing area. The cutting knife is responsible for the highest rate of dissemination of the disease. Infection is reduced to a minimum by not cutting seed thus not exposing cut surfaces to further infection by contact with machinery and containers. Other field tests showed that higher yields may be obtained by planting small whole seed than with cut sets.

The elimination of ring-rot bacteria from baled potato bags was effected by electronic heating. It was found that when a bale of 100 bags was exposed for 30 minutes in an electronic oven of 3,100 watt capacity and equipped with a 2,450 megacycle oscillator, all the ring-rot bacteria in the bags were killed. The temperature rose most rapidly at the centre of the bale, in contrast with conduction heating in which the temperature is highest on the outside.

Tuber Flea Beetle: In British Columbia, a single treatment of the soil with aldrin, dieldrin, or chlordane gave satisfactory control of the tuber flea beetle for two but not three years.

Beet Webworm: Field tests in Alberta showed that 1.5 pounds of toxaphene or heptachlor, 15 ounces of diazinon, or 4 to 6 ounces of endrin, applied in 30 gallons of water per acre with a row-crop sprayer at 30 pounds pressure, gave excellent control of mature larvae of the beet webworm. Failures that had been reported were attributable to poor coverage obtained with low-volume weed sprayers.

Root Maggots: In British Columbia 1 ounce of dieldrin, endrin, and heptachlor per pound of onion seed each provided good to excellent control of the onion maggot in muck and mineral soils, but malathion was not effective. In Quebec aldrin, dieldrin, and heptachlor each gave good control of the maggot when used at 1 ounce per pound of seed in mineral soils and at 2 ounces in muck soils. These results are in marked contrast to the very poor control reported from several places in the United States with much higher rates of some of these insecticides.

In Newfoundland aldrin and heptachlor in furrow and row treatments each gave satisfactory control of root maggots in rutabagas and in cabbage. In Prince Edward Island heptachlor and aldrin placed in 5 inch bands 1.5 inches below the seed each gave good control of maggots in rutabagas, but Guthion and Thimet did not.

A two row implement that ridges the soil, applies granular insecticides at any desired depth in the soil and, when coupled with a seeder, plants rutabaga or other seed in the ridge in one operation was developed at the Charlottetown laboratory. Plans and specifications of the implement, which costs about 200 dollars to make are available on request.

At Ottawa a preplanting application of granular aldrin or heptachlor gave satisfactory control of a severe infestation of root maggots in radish, but granular chlordane was unsatisfactory.

Apple Scab: Mixtures of an organis mercury fungicide and a protectant, both at half strength, were about equally effective against apple scab in 'after rain' schedules. Of the new fungicides tested, Cyprex and Dyrene gave excellent control although the latter was phytotoxic. Since sulphur was replaced by organic fungicides, scab control has improved, but powdery mildew has become a problem. The addition of 3 pounds of sulphur to each 100 gallons of organic fungicide spray controlled the powdery mildew.

Cyprex was the outstanding fungicide both as a protectant and an eradicant in the control of apple scab in Nova Scotia in 1957. Dyrene gave excellent control of scab but caused severe russetting. Zineb was effective as a cover spray for the control of late-season scab. Studies on mercury residues on apples showed that appreciable amounts of mercury were present 42 and 69 days after spraying.

In experiments in southwestern Quebec, good control of apple scab was obtained with captan, glyodin, Thioneb, and Niacide if they were properly applied, although the latter was somewhat less effective than the others. For the last three years, these fungicides have been applied to the same trees each year to determine their long-term effect on tree growth, yields, and fruit size. Trees sprayed with Niacide bore the longest shoots, heaviest crops, and largest fruits, while captan and glyodin had the reverse effect. Populations of the European red mite were smallest on plots sprayed with Thioneb and glyodin and greatest where captan was used.

In the apple scab trials at Creston, B.C., Cyprex gave all clean fruit with excellent fruit finish and no tree injury. Neither glyodin nor dichlone were quite so effective as Cyprex. The addition of a surfactant to dichlone reduced scab control and caused some fruit skin discoloration. Scab was heavy on the fruits of unsprayed trees.

Orchard Mites. In Ontario, Trithion gave good control of the European red mite in an orchard where parathion had failed, indicating that mites resistant to one phosphate miticide may be susceptible to another.

Codling Moth. In Nova Scotia ryania has been used with success for several years in apple spray schedules designed to interfere as little as possible with natural control agencies. Large amounts of the pure product, the only form available, had to be used to control the codling moth. In 1957, a new formulation containing 50 per cent rayania plus a sticking agent, used at 6 pounds per 100 gallons, gave better control than 100 per cent ryania at 5 pounds. Both formulations were innocuous to predaceous mites.

In British Columbia, diazinon gave as good control of the codling moth as DDT for the third successive year. However, lack of persistence of diazinon may allow late season infestation if the attack occurs several weeks after the last application. Another organophosphate, Trithion, gave control only slightly inferior to that from diazinon but was toxic to some varieties of apple. In Ontario Guthion was promising against the first brood of the moth.

The experimental insecticide Sevin gave excellent control of the codling moth in both British Columbia and Ontario. It gave promising results against the eye-spotted bud moth, aphids, the fruit tree leaf roller, the pear psylla, the lecanium scale, the oriental fruit moth, the plum curculio, and the red-banded leaf roller.

Concentrate Spraying: In British Columbia tests with three different automatic air-blast sprayers showed that a pump pressure of 75 pounds per square inch gave as good chemical deposits and as good control of the codling moth, mites, and aphids as the standard pressure of 300 pounds when nozzles giving good break up of the spray were used. Travel speeds of 1 and 2 miles per hour gave equally good results.

In Ontario, when equal amounts of pesticide were applied per acre with a large-capacity machine, equally good control of apple scab and insects was given at various concentrations of the pesticides up to 6X and speeds up to 3 miles per hour. The maximum travel speed for smaller machines is proportionately lower.

Forestry

Spruce Budworm: Aerial spraying with DDT was continued on a large scale against spruce budworm. The pine shoot moth can be controlled by carefully timed application of a 0.2 per cent DDT emulsion spray. Investigations during 1957 indicated that the critical spray period extended from the first evidence of larval feeding within the needle fascicles to the time the larvae begin to enter the buds, a period usually of about three weeks. Decrease in effective control is closely correlated with establishment of the larvae in the buds. A large volume of spray for complete coverage of the bud clusters and developing shoots is necessary, varying from 200 to 500 gallons an acre, depending on height and density of the stand.

Pine Root-Collar Weevil: Adult pine-root collar weevils can be controlled and egg laying prevented by spraying the bases of the trees and adjacent soil with dieldrin or lindane. Dieldrin emulsion at 0.2% applied in June, 1955 to trees $5\frac{1}{2}$ feet high at the rate of 0.87 pint per tree resulted in population reductions of 96% in the fall of 1955, 100% throughout 1956, and 98% during 1957. Lindane emulsion at 0.1% gamma applied in June, 1955 at the rate of 0.83 pint per tree resulted in population reductions of 89% during 1955, 100% during 1956, and 97% during 1957.

Larch Sawfly: Investigations showed that small mammals were among the most important factors that destroy larch sawfly cocoons. At least five species of shrews and five species of mice eat sawfly cocoons. An attempt was made to capture a strong colony of the cinereous shrew in Manitoba for release in Newfoundland. Here it is believed the animal should exert considerable control of the larch sawfly and similar forest pests. The mortality of the animals captured for this purpose was so high that the plan had to be postponed until more is known about techniques for reducing the mortality rate.

Black-Headed Budworm: The largest aerial spraying operation yet carried out in British Columbia was for control of the black-headed budworm on western hemlock. The operational spray solution, DDT in oil with emulsifier added, was applied at the rate of 1 lb. of DDT per U.S. gal./acre. The indicated control of about 90% was sufficient to prevent serious defoliation in 1957, Surveys conducted in the autumn of 1957 showed a light overwintering population of the black-headed budworm over the entire outbreak area. No serious defoliation is expected in 1958.

Studies on Fungicides

It has been shown in previously reported work that the dithiocarbamate fungicides such as nabam and zineb undergo oxidative decomposition to give the active component ethylene thiuram monosulphide. This reaction was reinvestigated because a recent Australian patent claimed that it was catalyzed by maganese. A trace of mangenese sulphate was found adequate, provided the acidity of the spray was not too high. This finding provided an explanation of several anomalies observed in the field use of these fungicides. It also accounts for the superiority of maneb over other metallic ethylene-bisdithiocarbamates.

Studies on Insecticides

The insect neurohormone, acetylcholine, has received special study. Its accumulation in the insect tissues when the normal controlling mechanism is destroyed seems to be the "biochemical lesion" produced by the organophosphate insecticides. Improvements have been made in the assay methods of acetylcholine, which accumulates in high amounts in housefly, roach, and mouse treated with TEPP, parathion, malathion or DEP. Of these organophosphate insecticides, malathion is of particular economic value because it is only slightly toxic to mammals.

In both insects and mammals, malathion is converted by oxidation to an active poison, malaoxon, but in mammals malaoxon and malathion are both broken down rapidly to nontoxic products. The breakdown is due to the presence in the molecule of a link easily ruptured by hydrolysis. On the basis of this knowledge, several organophospate insecticides were made, the most promising being acethion.

The related newly introduced commercial insecticide "Phosdrin" also has this weak link but does not require activation by the oxidative step. As the original dose is wholly active, the mammal is poisoned before it has time to decompose the compound; consequently Phosdrin is toxic to both mammals and insects.

(Report of the Minister of Agriculture for Canada for the Year ended March 31, 1958.).

GHANA

Cocoa Capsid Control: As a result of two years field trials it was considered possible to recommend a standard treatment for capsid control in mature cocoa, that is: "The application using mistblower of 1 pint Gammalin 20 (i.e. 4 oz. gamma BHC toxicant) in 5 gal. of spray per acre, repeating the application four weeks later. Thereafter maintain control by means of regular inspection and retreatment of localised areas only carried out as new damage is observed."

For treatment of young cocoa the recommended treatment is spraying, at least four times a year, with Kumakate (Didimac) which is 25% DDT miscible liquid. About 1 pint Kumakate is required to spray-paint one acre.

(Annual Report of the Department of Agriculture for the Year 1955-56.)

INDIA - MADRAS

Guinea-Worm Control: The effect on the destruction of *Cyclops* by the fishes *Rasbora* and *Chela* introduced into wells and tanks in three villages, is being studied. Other species used in public health control measures are *Gambusia*, *Etroplus maculatus* and *Barbus*.

(Administration Report of the Department of Fisheries for the Year 1956-57.)

MALAYA

Forestry

The following control measures are noted:-

Trees: Dieldrin was effectively used against termites and defoliators (mostly moths) of plants beyond the "nursery stage", and BHC (Gammexane products) in nurseries. Heavy defoliation in a plantation of *Albizzia falcata* by *Eurema hecabe contubernalis* was controlled by fogging the area with DDT miscible oil mixed with diesel oil. Heavy mite attack on *Chlorophora excelsa* and on some garden plants was controlled by sprays of "Akar". Preliminary trials with "Arikal", a deer repellent, on young rubber trees were successful.

Active attack by drywood termites was arrested by a dip treatment in dieldrin or heavy brush coating with Rentokil, but prevention tests with these insecticides have not yet given conclusive results. *Dyera costulata* timber dipped in three different insecticides (Dieldrex 15, Intox 8, Rentokil-BZ) and placed in contact with termite infested timber laid on the ground under cover gave, two years after treatment, excellent results with one, medium results with a second, and poor results with a third. There was no attack for the first 12 months on any of the test pieces. *Dyera costulata* timbers treated with boric acid and subjected to powder-post beetle infestation are free from attack after nearly 4 years.

Logs treated with Cryptogil DC.6, Endrex Nox-bora, OBD-5 and Timbertreat 620 gave very highly significantly better protection against insect attack than untreated control logs.

(Report on Forest Administration for the year, 1957).

NEW ZEALAND

Army Caterpillar Control. (C.M. Blick): Trials were carried out in the Warkworth district on an area of kikuyu grass which had been completely bared of foliage by a moderately heavy infestation of army worm, *Pseudaletia separata*. DDT and dieldrin were applied as sprays in water at $\frac{1}{4}$ and $\frac{1}{2}$ lb./acre and as dusts at $\frac{1}{2}$ and 1 lb. in $2\frac{1}{2}$ cwt. superphosphate per acre. Assessment of treatment effects was based on counts of caterpillars before and after treatment.

Seven days after treatment all treated plots had recovered and were bright green compared with the untreated plots which remained brown and devoid of leaf. Dieldrin gave a more rapid kill than DDT especially in the first 24 hours, and even after 7 days, DDT, though giving satisfactory results, was still inferior. There were no significant differences between the various rates of dieldrin and DDT used and method of application.

Based on this trial a rate of application equivalent to 4 oz. of pure dieldrin or DDT in water per acre or 8 oz. per acre as a dust appears to be adequate. Unfortunately there was no treatment with 4 oz. of pure insecticide applied as a dust. It is quite possible that this rate may be effective, but further experiments are required to check this point.

(New Zealand J.Agric., 1958, Dec.1958, 97, (6), 510.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BRITISH CAMEROONS .

Banana: Satisfactory control of banana leaf spot, Mycosphaerella musicola, has been obtained by the use of 60:40% Oil/water emulsion, which remains unbroken for 20 minutes (the time required to spray one tankful) after shaking, applied from a 75c.c. Kiekens machine at a dosage of 1 gal./acre. The use of water as an adjuvant reduced phytotoxicity, while at the same time providing sufficient volume to ensure efficient coverage.

("Plant Diseases in the British Colonial Dependencies." J. C. F. Hopkins F.A.O. Plant Prot.Bull., 1958, 7, (2), 19.)

EAST AFRICA

Mosquitoes

Flight Range and Survival. (M. T. Gillies): Studies have been continued on the release and recapture of Anopheles gambiae marked with coloured paints on the thorax. Flight appears to be at random as regards direction. There is a high mortality amongst the marked mosquitoes.

Age-Grading Techniques. (M. T. Gillies): Previously it had been possible to recognize the younger elements in A. gambiae populations by a method which combined the recognition of mating plugs, assessment of qualitative changes in the oviducts and ampullae, and measurement of the ampullae. This method left a small residuum of females whose age could not be accurately determined. A new Russian technique, which relies on the demonstration of clumps of pigment ("corpora lutea") in the terminal portion of the ovarioles of parous females, completely eliminates the uncertain group. Moreover it opens up for the first time the possibility of accurately determining the age of all female mosquitoes.

Taveta-Pare Scheme. (A. Smith): Anopheline infestation in dieldrin-treated houses kept to a very low level in most areas. The reduction in numbers was of the order of 91-94% during the past year. Anopheline infectivity was extremely low, of 1503 A.gambiae dissected from the Taveta area, one infected gland was found in a mosquito from the Chala area, and none infected out of 8359 dissected in South Pare.

Insecticides

Toxicity Hazards. (T. E. Fletcher): It is estimated that spraymen receive a daily skin contamination of the order of 1.8 mg dieldrin per kg bodyweight. Despite this appreciable level of contamination, no individual has at any time suffered even minor ill effects from employment in the teams. The absence of symptoms attributable to the dieldrin is considered to be due to a combination of reasons. The spraymen and pumpmen are provided with a uniform which provides a high degree of protection, and the issue of a spare overall enables this garment to be washed after each day's work. Liberal issue of soap, ½ lb. per man per week, enables a good level of personal cleanliness to be maintained. The dieldrin concentration of the formulation used is considerably weaker than that used in countries where poisoning of spraymen has been experienced. The use of stirrup pumps avoids contamination of the back, as often occurs with the compression sprayers used on many spray schemes. However the main factor is probably the reduced time of exposure to the insecticide, namely 6 hours a day for 180 days a year with an interval of 2 months between spraying cycles.

Resistance. (A. Smith): Studies on susceptibility have been continued by means of experimental huts, wall tests and Busvine-Nash tests, and it is concluded, from considerations of the results obtained by these different methods, that there has been no apparent change in behaviour, nor in susceptibility of *A.gambiae* to dieldrin, during the past year. It is reported that *Cimex hemipterus* from South Pare is extremely resistant to dieldrin, and *Culex fatigans* is about 10 times as resistant to dieldrin as it is in the untreated area.

Sorption. (J. M. Press - W.H.O.): The differences between the sorptive capacity of samples of soil were studied by adsorption of insecticide in a chromatographic column composed of the soil. It was found that dieldrin is adsorbed much more than gamma BHC, which in turn is adsorbed slightly more than DDT. The sorptive capacity increased as the particle size diminished, and appeared to be directly related to aluminium and iron content. It was noted that the silicon content was lowest in the most sorptive soils; but there was no correlation between sodium, potassium, magnesium and calcium content and sorptive capacity.

Value of a Spreading Agent in a DDT/Oil Larvicide. (A. S. Msangi): All natural waters have a surface film which, to a greater or lesser degree, impedes the immediate spread of droplets of oil that fall on the surface. It has consequently been assumed that larvicidal oils with a high spreading pressure would, other factors being equal, be correspondingly more effective. In trials carried out, spreading agents added to oil larvicides containing DDT gave no observable additional kill compared with oil solutions without spreading agents.

Engineering (G..Hill)

Insecticide Distributor: The prototype of an insecticide distributor, based on an agricultural seed fiddle, was prepared. This is intended for the distribution of granulated formulations as a larvicide, and it is now being offered for development to firms in Britain.

Water Flow Measurement: The applicability of methods of measuring water flow in streams and rivers has been reviewed. These methods are required in the practice of insecticidal control of *Simulium* breeding. The work suggests that most methods are either too elaborate and costly for use in rough country, or too unreliable. The conclusion, based on some field trials, is that the principle of a prepared glass tube, set into the current and with an upright measuring limb, namely Pitot's Tube, is most appropriate for this purpose.

(East Africa High Commission. Annual Report of the East African Institute of Malaria and Vector-Borne Diseases July 1957-June 1958.)

FIJI

Rhinoceros Beetle Control: In Viti Levu Island most of the breeding occurs within a few miles of the coast and heavy breeding is confined to the south-eastern corner. As an economy measure the searching and treatment of breeding places was discontinued and activity was concentrated on the collection of beetles from the crowns (about 4,500 were collected from over half a million palms), and treatment of the crowns with BHC- sawdust mixture. The rate of treatment of palm crowns was thus doubled.

The effect of crown treatments in the field is difficult to evaluate. Trials of this technique in Samoa, however, have given very promising results in the protection of young palms from damage by *Oryctes*. The treatment with BHC of sawdust output by sawmills also appears to have been very successful in drastically reducing breeding in sawdust heaps. It is becoming more apparent that the heaviest breeding of *Oryctes* occurs in the vicinity of villages, indicating that regulations regarding destruction of potential breeding places and disposal of rubbish are not being carried out.

Shipments of the predatory beetle, Scarites madagascariensis from Madagascar have been liberated in the field and Scolia ruficornis from the United States Trust Territory of the Pacific Islands, and nematodes from Ceylon and Madagascar are being bred and distributed.

Oryctes was detected in Viti Levu more than five years ago but it still has not spread over the whole island and become established in any other island of the Fiji group. Thus the control campaign has so far been successful in its primary objective of preventing the establishment of the pest in any island where copra production is important. Moreover, its effects on palms remain negligible, no single palm having been seriously defoliated or killed.

In Fiji island some Scarites madagascariensis were released but owing to the numbers of toads present it is felt that there is little hope of success with this or any other ground beetle. It is now felt that the only beetle predator likely to succeed in this country are such as normally fly, particularly any that normally move by day, such as Catocaspus spp. or histerids. Breeding and distribution of Scolia ruficornis is proceeding.

(Coconut Pests and Diseases Board. Report for Period 1st June 1957 to 31st May 1958. Legislative Council of Fiji. Council Paper No. 41 of 1958.)

KENYA

Forestry

Insect pests: Oemida gahani Dist: The leaving of Oemida-infested stumps in planting areas is thought to give rise to outbreaks of Oemida. Thinnings planted in grassland, where stumps are absent, have so far shown no sign of attack.

Ambrosia beetles: Experiments to compare the attractiveness of bituminous compounds, creosote, dieseline, engine oil, and pentachlorophenol, to Ambrosia beetles produced no evidence of increased attack, compared with untreated logs.

The most effective protection of logs against attack, was found to be afforded by insecticides containing 2 per cent gamma benzenehexachloride, both as a dispersible powder in water, and a solution in dieseline. Complete protection for more than three months was achieved. Further trials showed that reduced concentrations of gamma BHC and comparable dieldrin formulations were considerably less effective.

(Report of the Forest Department for the period 1st July, 1955 to 31st December, 1957)

MAURITIUS

Malaria Vector Control: The year under review can be described as one of routine and reduction. The incidence of malaria is now extremely low, but there is still slight transmission for which Anopheles gambiae is the obvious suspect, a suspect which to all evidence must be a poor vector in local surroundings. Difficulty has been experienced in breeding A.gambiae at the altitude of Curepipe where the entomological laboratory is situated; so a building has been taken over on the coast at Port Louis to be used as an insectarium.

Since A.gambiae does not rest in houses after feeding, two swing fog machines have been purchased to attack the outside resting places. When a positive blood smear is found, the plan of attack is in addition to residual spraying of the habitation: a) to fog the likely outdoor resting site; b) to treat the actual carrier with chloroquine; and c) to give phophylactic proguanil to the other members of the household.

During the year, 219,134 rooms were treated with one application of residual spray and 3,719 in the Mon Desert S.E. area received two applications. DDT 50% wettable powder was the insecticide most commonly used and was applied at the rate of approximately 170 mg of the para para isomer per sq. ft. In the Black River district and Mon Desert area the insecticide used was dieldrin at the rate of 45 mg per sq.ft. For better class houses DDT technical in kerosene or DDT emulsion is used. Hospitals, dispensaries, orphanages outside the spraying area were also treated during the year. The population in the residual spraying area is approximately 200,000 and the cost of spraying per capita is about R.*1.50. The cost per room treated is R.1.36. On breaking down the costing it is found that the cost per room for insecticide is 39 cents, labour 43 cents, transport 13 cents, supervision of labour etc. 38 cents, overalls, depreciation of sprayers etc. 4 cents.

Residual spraying, as at present carried out, will have to continue until answers are received on the resistance to the chlorinated hydrocarbo insecticides and on the resting habits of A.gambiae during the gonotrophic cycle.

During the year, frequent observations were made to compare the frequency of breeding sites for A.gambiae which was found in practically

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* R. = Rupee (= 100 cents) = 1s. 6d.

all classes of habitats as classified by Russell, with the exception of tree holes and special plant associations. The findings were as under:-

			%
Class	I.	Permanent or semi-permanent standing fresh water	34.4
Class	II	Transient fresh water ground pools	31.2
Class	III	Permanent or semi-permanent running fresh water	7.1
Class	IV	Container habitats	17.0
Class	V	Brackish water	10.3
		Total	100.0

Near the coast, typical A.gambiae breeds in brackish water containing up to 16.85 grammes NaCl per litre.

An interesting feature of the year's work is constituted by the preliminary observations of Mr. Mamet, the newly appointed entomologist, on the nocturnal activity of A.gambiae. They show that this species though normally starting feeding as early as between 19 and 20 hours, reaches its maximum activity between 23 hours and 3 hours, with peaks between 23 and 24 hours and between 2 and 3 hours.

These results suggest that A.gambiae has lost its crepuscular habit previously reported by Halcrow (1954) and that the nocturnal activity of the Mauritian gambiae seems to match fairly well with that of the African gambiae which reaches the peak of its cycle late into the night i.e. between 1 and 4 hours, declining rapidly one or two hours before dawn.

Extensive surveys again failed to reveal any Anopheles funestus (once the main vector of malaria in Mauritius) and Aedes aegypti, and it is thus confirmed that they have been completely eradicated. Special search for Aedes vinsoni Mattingly also gave negative results and this species may well have disappeared.

(Annual Report of the Medical and Health Department 1956).

Agriculture

Pests and diseases that proved troublesome during the year 1956 included: (1) red spider mites, (2) bean flies (Agromyza), (3) thrips, (4) fruit flies, (5) red ants, (6) mole crickets and crabs (to seed beds) and (7) wild parrots (to maize), (8) late blight, of potatoes and tomatoes, and (9) bacterial wilt.

A fair degree of control of (4) on cucurbitaceous crops was obtained with lead arsenate, of (5) using aldrin and of (6) with "Agrocide 7" poisoned baits. No practical means of controlling the parrots were available which were particularly destructive in the south east of the island..

Experimental Work

Setaria Grass: A trial on the establishment of Setaria sphacelata from seed showed that treatment of the seed prior to sowing with dieldrin at 10 gr active ingredient per kg gave excellent results. Treatment with Arasan showed no significant improvement.

Seed Production: The production of seed bearers has been increased very largely but still demand is not satisfied. Control of Melanoagromyza with aldrin has made large scale bean production a very promising proposition.

Tobacco Seed Beds: Trials with Amarello and Bonanza varieties indicated that the optimum rate of sowing is ½ gr. of seed, with either 2, 3, or 5 gr of aldrin 40% E.C. applied per 100 sq. ft. of surface. This gives approximately 2" x 2" per plant which is considered the most desirable seed-bed spacing. Heavier seed rates give a stand which is rather too dense. This encourages weakly plants and fungous diseases develop to a greater extent.

In addition the use of a lead arsenate spray to control leaf cutting insects, of 'Perenox' to control fungal diseases and of Cheshunt compound against soil borne diseases is recommended.

Beans: A field of Pioneer bean was sprayed four days after germination with dieldrin at the rate of 1 litre dieldrin 30% in 40 gallons of water per acre. The object was to control Melanoagromyza phaseoli, which is capable of great damage. Control achieved was extremely good and percentage infestation for the crop was virtually nil.

(Annual Report of the Department of Agriculture for the Year 1956.)

NIGERIA FEDERATION

Malaria Vector Control: The incidence of, and deaths from this disease during the year showed a significant increase, deaths having gone up from 398 in 1956 to 627 in 1957. As we are all well aware, malaria is a preventable disease and is a scourge which is normally an obvious enough target for control and eradication by vigorous and sustained public health action. Unfortunately, the topography of Lagos - with its lagoon, low sandspit, swamps, foreshore with stretches of flat lowland, and several mangrove-covered islands separated by a maze of creeks, and with a large overcrowded urban area much of which still has a rather rural character as regards building, water supply, and environmental sanitation - is such that its mosquito breeding potential is very high and exceptionally difficult to control. To help deal with this problem the World Health Organisation has agreed to make available to the Public Health Department of the Lagos Town Council (which is responsible for the sanitation of Lagos) the services of an expert full-time sanitarian, who will arrive in mid-1958. In the meantime, apart from the present orthodox measures, effective control must await the conclusion of land reclamation schemes.

An unusually heavy and prolonged rainfall damaged bunds and tide-gates in all three divisions of the control area, with resultant flooding in the Idumagbo, Central Ikoyi, and South-East Ikoyi areas where mosquito breeding increased as a result. During the year, 260,554 water collections were inspected, in 1,805 of which mosquito breeding was found, comprising 1,073 Culex, 618 Aedes and 114 Anopheles species. The Aedes Index was 0.4 (0.3 in 1956). Some 1,300 gallons of Freetown Emulsion, 2,300 gallons of gas oil and 279 gallons of fuel oil were expended in larvicide measures.

The residual spraying of Lagos Airport Terminal Buildings was instituted in May, to be repeated at six monthly intervals, using DDT emulsion on the recommendation of the Specialist Malariologist, who advised against the use of benzene hexachloride (Gammexane) owing to the risk of resistance developing to this insecticide, a state of affairs already encountered in Northern Nigeria.

Federal Malaria Service: The initial success of the Malaria Control Pilot Project in Western Sokoto, which began in 1954, encouraged the Government of the Northern Region to approve plans, with assistance from UNICEF and WHO, for the expansion of the Pilot Project into a Mass Malaria Control Campaign which started in 1956 and since April 1957 has extended to cover an area with a population of half a million in the Emirates or Argungu and Sokoto. The merger of these two projects is now gradually taking place.

Throughout the area of the Pilot Project surveys have indicated a phenomenally high degree of resistance of A.gambiae to dieldrin, with linked cross-resistance to BHC, while tolerance of DDT has remained uniformly low. Several colonies of the resistant A.gambiae found in the Project Area and established at the Ross Institute in London have provided the first evidence of the mono-factorial inheritance of the specific resistance according to Mendelian principles. The resistance-bearing gene has incomplete dominance. This important finding led to the working out and application of a new method for detecting resistance in the field, whereby the LC 100 for the local susceptible strain is measured and survivors of this dosage are then selected. A higher LC 100 for the hybrid fraction of the population selects the pure homozygote resistant individuals.

The long term assessment of the effects of DDT spraying applies only to that part of the project area, some 200 square miles with a population of 43,000, so treated. In this area, after five half-yearly cycles of DDT spraying at 200 mg/sq.ft., a very substantial degree of control of A.gambiae and A.funestus has been achieved. The last infected A.gambiae was found in this area in September 1955. These encouraging entomological findings together with the coincidental marked reduction of malariometrical indices give rise to the hope that interruption of transmission by the use of DDT may be attained in due course. To speed up the complete interruption it is intended to assess in two villages the effects of mass chemotherapy with chloroquine and pyrimethamine. Since the middle of 1957 DDT has completely replaced BHC over the whole area of the Mass Malaria Control Campaign.

The resistance levels of A.funestus were determined for the first time. It was found that tolerance to DDT was slightly higher than that of A.gambiae, but tolerance to gamma BHC and dieldrin was considerably less. Experimental induction of insecticide resistance in Aedes aegypti and Culex fatigans was attempted. A new technique was elaborated for investigation of the susceptibility to insecticide of anopheline larvae, using short exposure periods of one hour.

A study was made of the genetics of dieldrin resistance in a colony established from A.gambiae trapped in a boys' school at Kano. This colony was found to be made up of a mixture of pure (homozygous) susceptible and resistant individuals together with the hybrids. The first generation in captivity appeared to be composed of homozygous resistants, hybrids and homozygous susceptibles corresponding to the ratio 49:42:9, satisfying the Hardy-Weinberg law for such mixed populations. However, subsequent generations built up homozygous resistants to 60% and over in the absence of experimental selection pressure, in conflict with the Hardy-Weinberg distribution, hybrids being insufficiently represented, Hybrid male sterility, as reported by Davidson for resistant-susceptible crosses, would not affect the distribution, moreover, examination of males from this colony failed to demonstrate any individuals with undeveloped testes.

Forty acres of swamp at Eleshin on Ikoyi island were sprayed from an Auster B8 aircraft fitted with a new type of rotary atomiser ("Micronair"); DDT was used, as a 5% solution in gas oil, at a dose of $\frac{1}{2}$ lb./acre, a droplet size of 80 microns, and a swath of 20-30 yd. released from a height of 30-40 ft. Test containers of anopheline and culicine larvae were exposed, and the degree of larval breeding in the area and the adult mosquito density in dwellings in the surrounding area before and after spraying were determined. The results showed an excellent kill in the open, with but little larvicidal effect where vegetation was dense. There was no effect on the density of the adult mosquito population in the surrounding dwellings.

(Annual Report on the Medical Services of the Federal Territory of Lagos for the Year 1957.)

SEYCHELLES

Coconuts: *Oryctes monoceros*: An attempt is being made to increase the multiplication of *Scolia ruficornis*, a parasite of *Oryctes monoceros*. This involved the collection of large numbers of *Oryctes* larvae from fallen coconut trees (in which they are often well protected from the parasite. and their removal to trays containing rotted coconut wood where they were freely exposed to parasitization. A supply of nematode parasites of *Oryctes*, now being investigated by the South Pacific Commission, was ordered.

Melittomma insulare: In the Praslin Pilot Scheme, untreatable palms were felled and burnt; treatable trees were treated with paradichlorobenzene and tar, and soil and husk vapour-seal.

Citrus: Following the introduction of the "Eddy Wasp" parasite in 1955/6 it is reported that black fly is no longer a problem in Mahe.

(Annual Report of the Agricultural Department for the Year 1957.)

SINGAPORE

Palms: Perforation of the leaves and petioles of the palms, *Phoenix*, *Licuala*, *Oreodoxa* and *Corypha*, by the rhinoceros beetle, *Oryctes rhinoceros* is reported. Some measure of control was attained by inserting paradichlorobenzene into the holes and plugging them with mud. Collection of grubs is said to be the best preventive measure.

Several *Sabal* and *Phoenix* trees have been killed and others disfigured by the red stripe weevil, *Rhynchophorus ferruginea* var. *schach*.

The larvae of this pest attack the growing point of the palm cabbag and eventually the fronds fall off leaving a bare trunk. Control was attempted by spraying with Agrocide and dieldrin but no satisfactory solution has been found, as the symptoms of attack are revealed too late to save the plants.

(Ann. Rep. of the Botanic Gardens Dept. for 1957: Colony of Singapore.)

TANGANYIKA

Cashew (Nachingwea)

Effect of *Helopeltis* on Young Trees: It was thought that young trees would not be attacked by *Helopeltis* to any extent and a trial was laid down in 12 acres of young cashew to determine at what age growth would begin to be affected. The area was divided into two blocks of six acres, one half being dusted each week with a 1% gamma BHC dust applied at a rate of about $\frac{3}{4}$ lb./acre and the other left undusted. Nine blocks of nine trees were marked out in each half of the field and measurements made, once a month, of the height of the trees together with notes on the *Helopeltis* attack.

Dusting began at the beginning of May when the trees were already about two months old. By July it was clear that *Helopeltis* is capable of inflicting extremely heavy damage on first year trees. No trees on the undusted half of the field escaped damage of some sort, this ranging from severe leaf spotting to complete death of the tree. Many trees died back to ground level but recovered by sending up suckers. Damage to dusted trees was very slight and confined to leaf spotting. The effect of *Helopeltis* on growth was considerable, the reduction in August for undusted trees being brought about by severe dieback of the leading shoots. It is interesting to note that these trees do not show an increase in rate of growth with the beginning of the rains, which is a marked feature of the growth curve of the dusted trees.

Pseudotheraptus wayi: In Handeni District in Tanga Province, where cashew is a new venture, the nuts of some trees coming into bearing for the first time were being badly attacked by *Pseudotheraptus wayi*.

Castor. (Ilonga)

The most striking observation from the 1957 castor breeding programme was the damage caused to the young inflorescences by Capsidae

(Miridae) and to fruits by Pentatomidae, particularly the green shield bug, *Nezara viridula*. The main pest of rattooned castor is the elegant grasshopper, *Zonoceros elegans* which ravages the vegetative parts of the plant.

Castor. (*Tengeru*)

The insect pests of castor have been surveyed. Damage to the buds and developing fruits is caused by a number of mirid bugs (of which *Lygus vosseleri*, Popp. is generally the most important), pentatomid bugs, (*Acrosternum pallidoconspersa* Stal., *Calidea bohemani* St., *Nezara viridula* L. and *Cryptacrus comes* Fabr. var. *rufopictus* Walk.) and the tortricid larva *Argyroploce leucotreta* Meyr. Leaf damage is caused by mirid bugs and young stages of the pentatomid bugs and by larvae of *Euproctis rubricosts* Fawcett and *Heliothis armigera* Hbn. Severe stem boring by the cossid larvae *Xyleutes capensis* Walk. has been recorded in the giant native castors only. The grasshopper, *Zonocerus elegans* Thnbg. is a general feeder on giant castors towards the end of the season.

Citrus. (*Lyamungu*)

Young citrus in nurseries were found to be infected with Gummosis (*Phytophthora* probably *parasitica* Dast.) This disease had been previously ascribed to *Fusarium solani* but it now appears that this is a secondary organism.

Coconut. (*Chambezi*)

An experiment to investigate the control of *Theraptus* has been started. It is hoped to effect biological control by encouraging the Maji Moto ant, (*Oecophylla longinoda*). To this end citrus, castor and guava are being planted in the rows of palms as nesting sites for this ant.

Coffee. (*Lyamungu Coffee Research Station*)

Leaf Rust: Leaf rust (*Hemileia vastatrix* Berk and Br.) has been severe in most localities in the past year, in some cases causing complete defoliation. Greenhouse trials with a large range of fungicides have been continued. Preliminary results show that mercury fungicides are more active than copper or organics but the trials have not so far stood the test of field conditions. Records of rust intensity throughout the year were taken at Lyamungu. The disease shows a well-defined periodicity and the actual number of sori present is at its lowest between the Short and Long Rains. The possibility of using eradicant fungicides at this time to reduce inoculum to a very low level before the Long Rains is under investigation. Trials have been started using copper in oil fungicides which have proved very satisfactory as fungistatics within leaf tissue with other pathogen/host complexes. A field trial using air-blast equipment to compare the organic fungicides zineb and thiram with copper have shown that these are somewhat inferior to copper as protective sprays.

Nematodes: Nematodes (Meloidogyne sp.) cause damage in coffee particularly in the Lushoto area. Trials with Shell Nemagon, a soil fumigant which can be applied to growing plants, have shown that the fumigant will reduce the nematode population in the top foot of soil but that the reduction is not so great at 2 feet level. No differences were recorded in the growth rates of treated and untreated coffee. The experiment is sited at Lyamungu and observations are continuing.

DDT Damage: Investigations were completed on the suspected DDT damage in coffee at Masama. It now seems likely that the DDT was either contaminated with a hormone weed-killer or that the emulsion had broken down releasing products which caused leaf distortion.

Control of Leaf-Miner (Leucoptera coffeella): Five organophosphorus insecticides (Chlorothion, diazinon, malathion, Metasystox and parathion) were screened against leaf-miner larvae actually mining in leaf tissue. Only diazinon and parathion were found to be effective at low doses. Dieldrin was found to be ineffective, and promising results from the previous years' work were not confirmed.

Working on mixed miner populations (i.e. all instars present) and examining only those visible to the naked eye it was concluded that 1¼ pints of diazinon 60% E.C. per 100 gal. and 2 lb. of parathion 20% wettable powder gave a 95% kill under field conditions. First instar larvae were much easier to kill and it is thought (not proved experimentally) that less than half of the above doses would effect a very satisfactory control. None of the insecticides gave any indication of affecting unhatched eggs or pupae.

On a field scale, spraying with parathion or diazinon gave variable results. In one estate two to three months after spraying and achieving a good mortality, the populations rose steeply until the new infestation was far higher than the original. Larval populations were mixed (i.e. all larval instars were present) and there was little sign of parasite activity. On another estate one spraying gave a good control, but there was no rise in population two generations after treatment. Leaf-miner was almost eliminated by natural factors, mainly, it is thought, by the parasite Ageniaspis sp. In other farms the results were intermediate between these two extreme cases. No efforts have been made to control moths. About two and a half acres of coffee were planted during the year to determine the effect of leaf-miner and leaf-rust, together and separately, on crop yields under three sets of conditions, viz.: no shade, banana shade, and banana and tree shade.

Coffee Thrips (Diarthrothrips coffeae): Because of the devastation of Oldeani caused by the common coffee thrips which showed signs of DDT resistance in 1956/57, a small field laboratory was set up to study thrips on the spot. Particular points to be studied include: the optimum dose of insecticides to effect control, the biological persistence of insecticides, and most important of all, to obtain dosage-mortality graphs (recording susceptibility of thrips to insecticides) so that future insecticide resistance may be detected before any harm be done. Unfortunately (for the work) the weather never allowed thrips populations to exert any pressure and there was no extensive outbreak. A measure of the dose of dieldrin required to effect control in a few minor outbreaks was obtained. On Kilimanjaro a few outbreaks of thrips were found and three cases were investigated. Unusually heavy rains checked the outbreaks just as they were developing well for experimentation. Of three cases investigated one case of apparent resistance to DDT was noted. All were sensitive to low doses of dieldrin.

Stephanoderes (Hypothenemus hampei): Results reported from Bukoba in the 1956 season (see P.A.N.S., 4, (3), 320) were confirmed in full during 1957. The experiment was extended to the second phase of research where two whole villages were treated, mainly to note whether other important (but at present dormant) pests were affected by the insecticide. In particular outbreaks of the Kenya coffee mealybug and lacewing bugs are feared. Pest assessment trials using single tree plots failed because of the rapid reinfection by the beetles from surrounding untreated trees.

Berry-Moth (Thliptoceras octaguttallis): This is now of major importance in some areas. A method of estimating crop losses due to this pest was investigated experimentally. Spraying immediately after flowering has given very satisfactory results on two estates. Other instances of spraying some weeks after flowering have given very variable, and not very good, results.

Insecticide Dosages and Persistence: In association with the Colonial Pesticides Research Unit a study of the chemical and biological persistence of chlorinated insecticides under field conditions was carried out. It was found that DDT, dieldrin and endrin were by no means as persistent in the field as was expected. The insecticide concentration diminishes rapidly during the first few days and then tails off slowly. Wettable powder deposits are lost more rapidly than emulsions. Using field collected Antestia as a test insect it was found that 100% mortality could be expected only if the insects were on the trees before or immediately after spraying. Afterwards the killing power declines very sharply. Certainly after the first day the kill is not economic. While after a few days very few Antestia are killed by the insecticide it is not yet known how the deposit affects smaller insects, particularly the parasites associated with coffee pests. Together with the field work similar tests are being made with potted plants. By the end of the year a laboratory sprayer built by Colonial Pesticides Research Unit gave reasonably consistent and reproduceable results. Some dosage/mortality lines of several chlorinated compounds have been obtained for Antestia.

Antestia (Antestiopsis lineaticollis) Control: All tests reported here were made with a tractor-drawn air-blast sprayer applying 80 gallons of spray per acre. The question arose during the year as to whether Antestia could be more economically killed by using other insecticides. This raised the question of whether the optimum amount of DDT was being used.

It is still too early to arrive at definite conclusions but tentative conclusions drawn from 9 tests with DDT, 12 tests with dieldrin, and 8 tests with endrin suggest that twice as much DDT has been used in the past as is really necessary, that ½-1 pint of dieldrin 18% emulsifiable concentrate per acre is necessary to kill Antestia, and the endrin 19.5% E.C. at ¼ and ½ pint per acre is insufficient to effect a control (in spite of initial results to the contrary). In exceptionally tall and bushy trees poor Antestia kills were obtained with both high dosages of dieldrin (2 pints/acre) and usual dosages of DDT. Tests carried out independently of this laboratory, but kept under observation, showed that ¾-1 pint of dieldrin 18% E.C. per acre achieved a good control using only 8 gal. of spray per acre. Perhaps surprisingly, the results obtained in the laboratory using DDT and dieldrin were very similar to those obtained in the field. Some tests (two on the Station and one independent) carried out with malathion as recommended by the Coffee Research Station, Kenya, indicate that malathion does not give consistently good results.

White Coffee Borer (Anthores leuconotus, Pasc.) Control: A final examination of experimental results from coffee treated with a ½% dieldrin emulsion during the last months of 1954 revealed that in four shaded plots the insecticide was still effective against ring-barking larvae. The remaining 24 plots had either been re-treated by the farmer or, in some cases, uprooted. Many dead larvae or incomplete burrows were observed in the treated plots. Many living larvae were found above the "treated zone" in both control and treated plots.

Sample discs of bark were taken from trees sprayed in 1954 and the Chemist of the Colonial Pesticides Research Unit, Arusha, found 9 mg/sq.ft. of dieldrin still persisting. (Compare this figure with 2 to 5 mg/sq.ft. of foliage when spraying against Antestia). It is believed that the initial dose of dieldrin was about 300 mg/sq.ft. and it is thought that about 50% of this was lost after six months' exposure in the field. The residual dieldrin seems to disappear more slowly. The 9 mg or 5½% is the quantity left after 2¼ years. Dieldrin lacquers as described previously have failed at this stage in all plots examined. This is considered to be due to the lacquer flaking off the tree rather than insecticide loss.

Brevipalpus phoenicis (Geijskes) was found in large numbers in several areas in the Northern Province and is thought to damage coffee cherry and prevent normal ripening, the green cherry becoming brown instead of bright red. In the laboratory the Plant Pathologist noted incidentally in a fungicide screening trial that all potted plants treated with copper oxide or copper oxychloride suspensions were heavily infested with B.phoenicis. Those treated with colloidal coppers (including Bordeaux) and other fungicides, and the control plants, were free of the mite. The various treatments were all placed at random in the test room and all had an equal chance of being infested. It seems possible, therefore, that the increased mite activity observed in the field may be due in part to the increasing use of ready formulated copper fungicides which are replacing the farm-formulated Bordeaux mixture.

Robusta Coffee. (Maruku Coffee Station)

Stephanoderes Control Trials: The trials carried out in collaboration with the Coffee Entomologist, Lyamungu were continued. As in previous years endrin spraying has greatly reduced Stephanoderes damage. Endrin has also significantly reduced the damage caused by coffee berry moth. A pest assessment trial was started in August, to estimate the effect of Stephanoderes control by endrin in increasing yield and improving quality.

Cotton. (Ilonga)

Cultivation Trials: 10% DDT and 3% BHC was used in all the trials. In a time of planting trial at Lumemo the yields of cotton on untreated plots were compared with those treated with insecticide. Treated plots had yields approximately twice those of the untreated plots. The main pests were American bollworm, spiny bollworm and stainers.

Insecticide Trials: The standard insecticide application recommended to growers is 1 lb. DDT per acre per week, over a period of two months, with the inclusion of ¼ lb. BHC as an aphicide when required. Trials were carried out to find methods of reducing the total amount, and hence the cost, of insecticide used, without any considerable increase in insect damage.

Trial No. 1. As the greatest amount of crop loss due to American bollworm takes place during the period of formation of buds and small bolls it was considered that if adequate protection was given during the first month - up to the peak of flowering - the rate of application could be reduced during the second month. Alternatively the rate could be reduced in each second week to a level just sufficient to prevent the pest population from increasing above that of the previous week. The following treatments were given:

Treatment	lb. DDT per acre per application 1st Month	2nd Month	Total DDT lb.
A	1	1	8
B	1	½	6
C	1	¼	5
D	1	0	4
E	1	and ½ alternating	6
F	1	and ¼ alternating	5

The "standard" treatment of 1 lb. DDT per acre per application gave the highest yield and the greatest net return. Where the total amount of insecticide was reduced, either by applying lower rates in the second month or by alternating high and low applications, good control was still achieved. There seems to be an advantage in the "alternating" system over the simple reduction in the second month, although the yields were not significantly different. Neither of these variations gave the same economic return as the constant high rate.

Trial No. 2. The inclusion of BHC in a spray is recommended as an insurance against possible aphid attack and to assist in the control of pink bollworm, which is not effectively controlled by DDT. This adds considerably to the cost of treatments if continued throughout the whole spraying period. It was considered that if cotton is planted relatively early so that the crop is near maturity at the end of the rains, an aphicide would only be needed during the last few weeks of treatment. A comparison was made between applications of DDT only, DDT plus BHC during two months, and the addition of BHC in the second month only. Pink bollworm did not cause serious damage. The addition of BHC in general led to slightly higher yields, but in no case were they significantly greater than DDT alone, and the treatments including BHC for the second half of the protection period were as effective as those in which BHC was used for the whole period. The higher (1 lb.) application of DDT again gave a better net return.

Trial No. 3. Another possibility for reducing costs is the use of the cheaper locally formulated insecticides. A small trial, comparing a locally produced emulsion with an imported product, was therefore carried out. A comparison was also made of swirl nozzles, giving a fairly coarse spray, and fine ceramic nozzles. Yields from this trial were very satisfying as they represent the highest yields obtained from a standard insecticide treatment. The highest plot yield was equivalent to over 3,000 lb. seed cotton per acre. All treatments gave very good control. The better quality insecticide gave the highest yields, and although much more expensive, also the greatest net return. There was no significant difference between the "coarse" and "fine" sprays in final yields, but the pest records indicate that the coarse sprays may be a little more effective in the control of spiny bollworm.

Cotton. (Lake Province)

Insecticide Trials: A series of demonstration plots was laid down at various sites in the main Lake Province cotton areas. Unsprayed cotton was compared with cotton which had received the standard insecticidal treatment recommended, i.e. four applications of 1 lb. DDT per acre followed by four weekly treatments of 1 lb./acre DDT and $\frac{1}{4}$ lb./acre BHC. The anticipated outbreak of cotton pests, and in particular American bollworm, did not materialise in the main cotton growing areas, but in North Musoma and North Mara Districts insect attack was heavy and from these areas were obtained the most striking results of the trial. The cost of the spraying, was, however, too high (over Shs. 180/- per acre) for it to be an attractive proposition to the African cotton grower. Further trials and observations are being planned paying particular attention to the eventual cost of spraying by the farmer, which to be attractive must be below Shs. 100/- per acre. Spraying commenced during March and continued into May. The mean yield from undusted cotton was 443 lb. of seed cotton per acre. The mean response from insecticidal treatment was 332 lb. (± 132 lb. at the 1% fiducial limit) a very valuable and appreciable response.

Cotton. (Ukiriguru)

Bacterial Blight (Xanthomonas malvacearum) - Seed Treatment: Testing of various new copper and mercurial formulations continued. In addition, large scale tests were carried out in one of the Booth Drums.

Whilst scores of cotyledon lesions consistently demonstrated the superiority of mercurial over copper dressings at the same rate of application, the results of one trial showed that Perecot applied at rates of 1:100 and 1:200 parts by weight was comparable with Agrosan GN5 applied at 1:300. In view of these results a recommendation was made that the rate for seed treatment with Perecot in the Province generally be increased from 8 lb. to 9 lb. per ton (giving a rate of approximately 1:250).

Tobacco. (Lyamungu)

Anthracnose (Colletotrichum tabacum Boning) was recorded for the first time in Tanganyika in December causing severe losses at Urambo and Lupa Tinga Tinga. This disease has been responsible for considerable damage in the Rhodesias over the past few years and it is not controlled by copper fungicides. Zineb fungicides have given excellent control and though all farms have been affected in the areas in question and there is a serious shortage of seedlings, the situation is improving steadily.

(Annual Report of the Department of Agriculture, 1957. Part II.)

Tobacco: Tobacco anthracnose, Colletotrichum tabacum, has been newly recorded here and is at present confined to Urambo and Chunya, where the Hicks variety imported from Southern Rhodesia is grown. Zineb sprays regularly applied have given excellent control. The Southern Highlands tobacco area is reported to be free from the disease.

("Plant Diseases in the British Colonial Dependencies." J. C. F. Hopkins. F.A.O. Plant Prot.Bull., 1958, 7, (2), 20.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

HAWAII

Sugar Cane

Insects: The sugar-cane borer, Rhabdoscelus obscurus continues to be the only serious harmful pest; the anomala beetle is efficiently controlled by the wasp Campsomeris marginella modesta; armyworms have been almost absent except for an outbreak of Pseudaletia unipuncta. A study of this outbreak showed the absence of all but one parasite, the tachinid, Eucelatoria armigera; the introduction of the braconid, Apanteles militaris from the Southern United States is being considered.

Diseases: The systemic fungicide "Bayer 22555" was highly effective for the control of Pythium root rot when applied to growing cane seedlings as a drench at the rate of 1 g. in 1 litre of water per flat. This material stopped the spread of the disease when applied after some plants in the flat had become affected. The results suggest that one application of Bayer 22555 might be made to seedlings prior to moving them from the glasshouses, and that subsequent treatments be made only in the plants which become affected with Pythium.

Soil Fumigation: Results of laboratory studies to compare the effects of DD (1:3 dichloro-propene + 1,2-dichloropropane) and other fumigants on soil micro-organisms, indicate that Vapam (sodium N-methyl dithiocarbamate) at 50 gal./acre was as effective as DD at 40 gal./acre in completely inhibiting nitrification of added ammonium sulphate (500 parts N per million parts soil) for at least 8 weeks. PRD (3:4-dichlorotetrahydrothiophen 1:1-dioxide at 40 lb. active/acre) and allyl alcohol (20 GPA) were less toxic to the nitrifying bacteria, no complete inhibition of nitrification being observed.

An interesting observation was the 90% reduction in the total numbers of fungi, which persisted for about 20 weeks, in soils treated with Vapam; the Trichoderma fungi population was also markedly reduced, being only a fraction of that in other soils. Other fumigants had little or no effect on the total numbers of fungi, but allyl alcohol was found to increase the Trichoderma population one and a half to four times that present in the soils containing other treatments at the expense of some other species. The effects of Trichoderma spp. on Pythium and cane growth have been tested. In one case a Trichoderma isolate inhibited the damping-off of seedlings. Further work is planned inasmuch as the Trichoderma fungi are considered one of the important groups of micro-organisms which are antagonistic to some of the root-infecting fungi inhabiting the soil.

Rat Control: Endrin is being investigated as a rat poison. It will not kill rats in the field as it does mice but shows useful characteristics as an internal poison at relatively high concentrations. Endrin does not appear to be easily detected by rats, kills quickly after ingestion of minute quantities and is insoluble in water. It shows promise as the lethal component of a bait being developed for broadcast by aircraft or land vehicle and appears particularly suited for use in combination with a new carrier, a milk dog biscuit, which is being investigated. Bait is prepared by soaking the biscuits in an acetone solution of endrin. This bait is, quick killing, resistant to moisture, fungus and insects, and is easy and safe to handle. The biscuits cannot be used economically on a large scale in the shapes in which they are now marketed but the manufacturers are prepared to manufacture other shapes if there is a large enough demand for them. Field tests of thallous sulphate-maize in prebait poisoning have been conducted but the results show no clear-cut advantage over the usually employed mixture of thallous sulphate and rolled oats.

(Hawaiian Sugar Planters' Association, Experiment Station Committee. Report October 1, 1957 to September 30, 1958).

SUDAN

Cotton: Ground or aerial spraying with DDT was carried out against jassids over 96% (225580 feddans*) of the cotton area.

Jassid infestation was heavier than usual in the cotton variety X1730 and average in the Sakellarides variety whilst fairly heavy reinfestations after initial control by DDT spraying occurred in November except in the South. Thrips were heavier in the South and Centre Groups than in the previous year but negligible elsewhere. White fly was much lighter than previous years and attempted control with parathion added to DDT was again unsuccessful.

* Feddan = 1.038 acre.

(Fifth Annual Report and Statement of Accounts of the Sudan Gezira Board for the year ended 30th June, 1955).

PROPRIETARY DATA

BAYER AGRICULTURE LTD.

Botrytis cinerea, the fungus responsible for grey mould, causes heavy losses every year on a wide range of horticultural crops. *Botrytis* often completely destroys lettuce seedlings, tomato plants and flower cuttings; it also spoils fruit and flowers of many other glasshouse crops so that they are unmarketable. The humid conditions of glasshouse cultivation are particularly favourable to the development and spread of the disease, and if plants become damaged by cultivations, wilting or from other causes, *Botrytis* will quickly take hold and may spread through an entire crop.

For the control of this disease Bayer Agriculture Ltd. are marketing "Folosan", a dust formulation based on tetrachloronitrobenzene, (T.C.N.B.), which has the effect of arresting the development of *Botrytis* in all stages of growth, by inhibiting the germination of the sclerotia or resting bodies, stopping the growth of existing infections and preventing the production of spores and the further spread of disease. The dust can be easily applied by any hand or mechanical blower and the dosage indicated is 1/8 to 1/4 oz. per sq.yd. of floor area, depending on the amount of foliage present. In the suggested glasshouse procedure the dust is blown into the air and allowed to settle. The treatment can remain effective for up to 14 days but should be repeated at 10-day intervals, if necessary.

Attack by *Botrytis cinerea* on lettuce is through tissue damaged mechanically or by other disease organisms, particularly by a soil fungus, *Rhizoctonia*. For control of the latter and to supplement the treatment described above, Bayer Agriculture Ltd. markets 'Botrilex', a powder fungicide based on pentachloronitrobenzene. This should be mixed uniformly into the top 3" of soil, under cold glass, at 2 oz. per sq.yd., 2-3 weeks before sowing. "Botrilex" is also recommended for the protection of tulips against "Fire" (caused by *B. tulipae*) and grey bulb rot, of onions against white rot (*Sclerotium cepivorum*), and of bulbs and corms (tulips, gladioli and narcissi) during storage.

DI-ISONITROSO
ACETONE MONO-DIBUTYLAMINE SALT

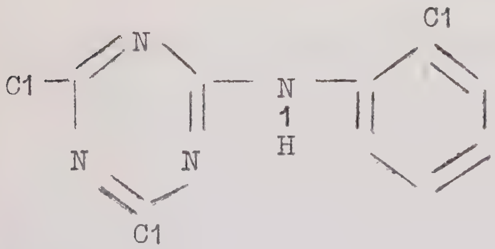
Synorganics Inc., Baltimore, Maryland, U.S.A.

A yellow crystalline solid (m.p. $124-126^{\circ}C$, decomp.) slowly soluble in water and alcohols. It develops a characteristic magenta colour in the presence of micro quantities of certain organophosphorus compounds, (e.g. DFP and TEPP) acid anhydrides, acyl halides and positive halogen compounds, (e.g. N-bromosuccinimide), and is adaptable to their qualitative or quantitative determination.

(Ref. S.Sass et al., Anal.Chem., 1957, 29, 1346.)

DYRENE (B.622) - NEW FOLIAGE FUNGICIDE

Ethyl Corporation and Pittsburgh Coke and Chemical Company.



This substance, chemically 2,4-dichloro-6-(o-chloranilino) triazine, is produced as a white to tan, crystalline solid, m.p. $159-160^{\circ}C$. It is practically non-volatile and is insoluble in water. It is stable in neutral or slightly acid media but decomposes fairly rapidly in basic media at elevated temperatures.

Mammalian Toxicity

The acute oral LD 50 for female rats (single oral dose in peanut oil) was found to be 2,710 mg./kg. On rabbits the LD 50 (single oral dose in peanut oil) was 460 mg./kg. For other species tested by the same method, the MLD was: for male cats, greater than 604 mg./kg.; for female monkeys, greater than 3,200 mg./kg.; for female dogs, greater than 7,100 mg./kg. In chronic feeding tests on rats, there was no evidence after two years that a concentration of 5,000 p.p.m. in the diet was harmful. Dogs, both male and female, fed from ¼ g. to 1 g./kg. per day for from a year and-a-half to nearly two years lost some weight. The animals given the larger dosage showed enlargement of the liver, kidney, and spleen at necropsy while the dogs given the lower dosage showed only spleen enlargement. No other abnormalities were evident. 9.4 grams of B-622, as a paste in peanut oil or dimethyl phthalate, kept in contact with the skin of rabbits by the sleeve method for 24 hours, resulted in local erythema edema, ulceration, fissuring and incrustation. The skin applications also resulted in toxic degenerative changes in the liver and kidneys of the treated rabbits. It is thus evident that the oral toxicity of B-622 is low, but that there is some evidence that long contact with the compound may cause skin irritation. Preventive precautions should be taken.

Fungicidal Effectiveness

B-622 has had six years of research investigation in the field as a 50% wettable powder formulation. Extensive work has been done on potatoes and tomatoes, for control of early and late blight, anthracnose, *Septoria*, *Botrytis*, and *Stemphylium* on the respective potato or tomato host which these diseases affect. Residue tolerances of 10 p.p.m. for tomatoes and 1 p.p.m. for potatoes have been established and no specified time interval is required between last application and harvest. Purple blotch on onion, anthracnose on cucurbits, blights on celery, and scab on apples have been effectively controlled. Preliminary studies have shown effective control of downy spot and scab of pecans; grey mould on strawberries; *Helminthosporium* leaf blight on corn; *Stemphylium* on gladiolus; and brown spot, dollar spot, and snow mould of turf. Early formulations showed a tendency toward phytotoxicity on several crops. Recent field observations indicate that this problem has been overcome by formulation improvement except on fruit and some ornamentals. The dust formulation has been tested for two seasons and its performance is equal to that of the wettable powder.

Potato blights are effectively controlled at 1-1½ lb. a.i./acre; also *Alternaria*, anthracnose and *Septoria* on tomatoes, *Helminthosporium* leaf spot of sweet corn, and early and late blight of celery. *Alternaria* on onions is controlled at 1 lb. a.i./acre.

Samples of B.622 dust or B.622 50% wettable powder can be obtained from the Company on request. A brief indication of the proposed trials should be given.

METHYL MERCURY NITRILE

Active principle in "Chipcote" Seed Disinfectants manufactured by Chipman Chemical Co. Inc.

Products are:

(1) "Chipcote 75" containing 1.85% a.i. methyl mercury nitrile equivalent to 1.5% wt. metallic mercury,

(2) "Chipcote 25" containing 5.41% methyl mercury nitrile equivalent to 4.5% metallic mercury.

Chipcote 75 is a liquid seed disinfectant suitable for use, without dilution, in ready-mix and mist-type applicators. Normal rate is ½ to ¾ fl.oz. per bushel. The more concentrated product, for use in slurry seed treaters, is normally applied at ¼ fl.oz. per bushel, after dilution with water. They are indicated for the following disorders: stinking smut or bunt on wheat and rye; covered or black smut and leaf stripe on barley; smuts, leaf stripe and Victoria blight on oats; kernel smut on sorghum; seed decay, pre-emergence seedling rot or damping off on flax and small grains generally; seed decay of rice; and on cotton to increase stands of healthy seedlings by reducing infection from surface seed-borne anthracnose and bacterial blight and pre-emergence damping off, especially with early plantings. (Loose smut of wheat and brown or loose smut of barley are not controlled by chemical seed treatment). These "Chipcote" formulations contain a sticking and spreading agent and a red marker dye. Aldrin may be added for effect against wireworms.

PHENKAPTONE

The Geigy Co. Ltd., Rhodes, Middleton, Manchester, or 42, Berkeley Square, London, W.1.

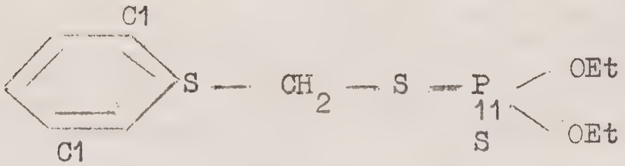
This acaricide based on a dithiophosphoric acid ester was first synthesised in the Geigy laboratories in Basle. It is claimed: to give very good control of red spider and other mites at all stages, including summer eggs; to have a good penetrative action and residual effect; and to be comparatively harmless to bees and other beneficial insects. Field trials have not revealed any phytotoxic effects.

Toxicological Studies

The oral LD 50's of the active ingredient in gum arabic were: mouse, 293, rat 182, guinea-pig 148 and rabbit 48 mg./kg.

Phenkaptone is formulated as 20% emulsifiable solution, 20% wettable powder, 20% aerosol solution and as a low pressure aerosol.

Recommended rates of application: for high volume spraying in orchards are 1 lb. wettable powder or 16 fl.oz. emulsifiable solution per 100 gal. of spray, and 32-40 fl.oz. emulsifiable solution for applications at 50 gal./acre. In glasshouses sprays or aerosols may be used.



Phenkaptone (0.0 diethyl-S-(2:5 dichlorophenyl mercapto methyl)-dithiophosphate)

PLANT PROTECTION LTD. has issued the following literature:-

FARMERS' GUIDE TO PLANT PROTECTION

An enlarged edition set out under four main headings (weedkillers, insecticides, fungicides, and seed-dressings), each sub-divided under the relevant crop. For convenience it has been side-indexed and provided with a crop reference. (pp.43).

LOW VOLUME SPRAYING

Folder, similar to that issued previously.

GUIDE TO PESTS AND DISEASES OF FRUIT

Similar to the previous issue. (pp.42).

THE SHELL PETROLEUM COMPANY LTD. has issued the following bulletins:-

Agricultural Bulletins

ADB:654/No.3. "Application of Emulsifiable Dibromochloropropane in Irrigation Water as a Preplanting Soil Treatment."
J. H. O'Bannon.

ADB:662/Fc.30. "Dieldrin Sprays as a Control for Frit Fly in Spring Oats."
J. H. Fidler.

ADB:441/Sd.17. "Control of Sugarcane Termites (1946-1953)."
S. B. D. Agarwala.

ADB:437/Sd.16. "Control of Snouted Harvester Termites."
E. K. Hartwig.

ADB:418/Sd.15. "Control of Termite Attacking Live Wood of Tea."

ZALDECIDE DRY POWDER BLOWER
Newton Chambers & Co. Ltd., Sheffield.

This is a trigger operated cylindrical blower weighing 18 lb. when charged with 7 lb. of powder. It is fitted with a Schrader valve and pressure gauge. Before use a foot pump is coupled and the blower pumped up to a working pressure of 100 lb. p.s.i. It is specifically designed for use with Zaldecide-D and -M powders, 7 lb. being claimed to give coverage up to 1 acre.

For use indoors, under floorboards and other inaccessible places a 3 ft. flexible tube fitted with a special nozzle may be attached to the blower.

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ABSTRACTS

THE ROCKEFELLER FOUNDATION ANNUAL REPORT, 1957

(Address by the President, Mr. Dean Rusk)

Arthropod-Borne Viruses

"Knowledge of the number of different agents is of cardinal importance in the study of arthropod-borne animal viruses. The system of classification adopted depends entirely on immunological principles. It has been found that when an animal is infected with one agent, it produces antibodies not only to this infecting agent but also, to a greater or lesser extent, to allied viruses. A knowledge of these immunological overlaps is of great importance not only for classification of the viruses but also for interpretation of serological findings.

Three methods are available for the demonstration of antibodies. The first is the hemagglutination-inhibition (HI) test which depends upon the ability of many of the arthropod-borne (arbor) viruses to produce a clumping or agglutination of the red blood cells of certain birds. An immune serum prepared to the virus used in the test has the ability to prevent or to inhibit this hemagglutinating effect. Hemagglutination inhibition will also occur, though usually to a lesser extent, with immune serums prepared to any allied virus.

The second method, known as the complement-fixation (CF) test, is very complex but, like the HI test, is performed in test tubes and shows a great deal of immunological overlap between allied viruses. While, to date, hemagglutinating antigens have been prepared from only 40 distinct viruses, complement-fixing antigens have been prepared from all. The third, and often the most specific test, is the neutralization test. In this test the power of an immune serum to protect an animal by neutralizing the virus is determined.

The complexity and extent of The Rockefeller Foundation virus program are shown by the fact that up to the present time more than 70 distinct viruses have been discovered. Many of these belong to three immunologically related families which have been called groups A, B, and C. To group A belong such important agents as the viruses causing eastern, western, and Venezuelan equine encephalomyelitis of the Americas. During the course of the year three new agents belonging to this group were discovered. One, the Middelburg virus, was isolated from mosquitoes in South Africa, and two were isolated, also from mosquitoes, in Malaya. The importance of the three new agents as causes of human infection is not known at present.

Group B is the largest and most important of the groups. To it belong such agents of human disease as yellow fever, dengue, and St. Louis, Japanese B, Murray Valley, and Russian spring-summer encephalitis viruses. Within the group several subgroups of closely allied agents can be clearly distinguished. One consists of yellow fever, Uganda S, and H 336 viruses. The last, at present unnamed, was isolated in South Africa from the blood of a child suffering from fever. The two types of virus producing dengue fever in man are very closely related and form a distinct subgroup. To another subgroup belong St. Louis, Japanese B, and Murray Valley encephalitis viruses, and West Nile and Ilheus viruses. It is possible that the Bussuquara virus, recently isolated from a sentinel monkey in the Amazon Valley, belongs to this group. Nothing is known concerning this agent's possible importance as a cause of human infection."

Another clearly defined subgroup has been named the Russian tick-borne complex. The members of this subgroup, are all transmitted by the bite of a tick and include louping ill virus, (in sheep), Russian spring-summer encephalitis (RSSE) or Russian tick-borne encephalitis which are transmitted by Ixodes, and the viruses causing Omsk hemorrhagic fever and biundulant fever. Also belonging to this subgroup is Kyasanur Forest disease (KFD) virus causing disease in monkeys and man in India. Entomological investigations indicated that mosquitoes were improbable vectors. When this virus was found to belong to the Russian tick-borne group the possible role of ticks was investigated and KFD virus was isolated from Haemaphysalis.

The immunologically close relationship of KFD virus to RSSE virus suggested the use of a vaccine to protect the local exposed population. In Russia a killed vaccine is used against RSSE, inactivation of the virus being produced by formaldehyde. A vaccine prepared with KFD virus had a very poor immunizing quality so a vaccine with a strain of RSSE virus was prepared by the Walter Reed Army Institute of Research and sent to India. A serious disadvantage of such vaccines is that three inoculations are necessary and the immunity, being of short duration, requires a yearly "booster" inoculation. The logical solution is the development of a living attenuated vaccine, like the 17D for yellow fever which produces an immunity of many years' duration with a single inoculation. Experiments are now in progress in an attempt to develop such an attenuated strain.

"With one possible exception, all the tick-borne viruses in group B are members of the Russian tick-borne complex. The possible exception is the agent of Nairobi sheep disease which has been known for many years as a severe tick-borne viral infection of sheep in East Africa.

Recent studies with immune sera obtained from the East African Virus Research Institute in Entebbe indicate that, in all probability, this agent is a member of group B. The serological studies to date do not indicate that Nairobi sheep disease is closely related to RSSE.

Group C, the third group of immunologically related agents that has been established, has so far been isolated only near Belem in South America. Furthermore, more members of group C than of the other groups have been isolated in that region. Intensive studies have indicated that at least five clearly distinguishable viruses, which have been named Apeu, Caraparu, Marituba, Murutucu, and Oriboca, are present. All have been isolated from sentinel animals, and three, Caraparu, Marituba, and Oriboca, from humans and mosquitoes as well. Limited surveys for antibodies in the sera of residents indicate that infections with group C agents are very prevalent indeed. Very little is known concerning the clinical manifestations in man. Although no viruses belonging to this group have, to date, been isolated in Africa, surveys with sera indicate that infections of man with members of the group are fairly prevalent.

Of all the arthropod-borne viruses studied to date, 37 have been shown to be members of one or another of the three groups. Approximately 38 remain that appear to be distinct identities and to have no relationship to any of the three immunological groups. These viruses form a very heterogeneous collection. Very little is known about many of them, and it is possible that some are of no importance in the production of infection in man and his domestic animals. However others, of which a few will be mentioned, are of definite public health interest.

Rift Valley fever, at present known only in Africa, is the cause of extensive epidemics in sheep and produces abortion in pregnant ewes and high mortality in lambs. Blue tongue, also a disease of sheep, is of considerable economic importance. It was thought, at first, that blue tongue was confined to the Ethiopian region, defined as Africa south of the Sahara, but it has in recent years been reported from Egypt, Israel, the island of Cyprus, and the western United States. One of the first animal diseases shown to be caused by a virus is African horse-sickness. Until a vaccine was developed, this disease was a very important cause of mortality in horses in Africa, the only region where the virus has been found. Both blue tongue and horse-sickness are transmitted by small biting flies belonging to the genus *Culicoides*. In the Mediterranean, two distinct viruses produce infection in man, at times in epidemic form. The disease in man is generally known as sand-fly or *Phlebotomus* fever. In parts of the western United States Colorado tick fever, a disease transmitted by ticks, is prevalent.

An analysis of the distribution and prevalence of the different arbor viruses in various zoogeographical regions is very illuminating. The most striking finding is that the tropical regions have supplied by far the greatest number. Of these, South America leads with 27 distinct viruses. The Ethiopian region is a close second with 24. In the third great tropical area, the Oriental region in which belong India, Malaya, the Indonesian Archipelago, Indo-China, and the southern portion of China, 15 distinct arbor viruses have been isolated to date. In North America to date, nine distinct arthropod-borne viruses have been described.

Tropical regions are distinguished from the more temperate zones by the abundance and variety of animal life. It is probable that all the arbor viruses are maintained in nature by cycles involving vertebrates as well as arthropods. Furthermore, in the tropics the marked seasonal changes characteristic of regions distant from the equator are absent. As a consequence, conditions are often favourable for the year-round breeding of both vertebrates and arthropods and thus for the year-round maintenance of the virus cycles. It is not surprising, therefore that it is in the tropical regions that the greatest variety of arbor viruses is found.

Three serological techniques are available for the identification of newly isolated viruses. Because they are biological reactions, these tests are subject to a great deal of variation, particularly the neutralization test. It is consequently often impossible to decide if a newly isolated agent is identical with or only closely related to one of the reference viruses. This problem has arisen chiefly in the large group B where immunological overlaps are often very marked. The development of antibody adsorption techniques has provided a very valuable method for determining more clearly the antigenic relationship between the various members of the group. The principle of this technique is basically very simple. If, to an immune serum an excess of the homologous virus is added, and, after incubation, the mixture is submitted to high-speed centrifugation, the virus particles with the adsorbed antibodies are sedimented. In this way all the antibodies are removed. Adsorption with an excess of a closely related virus removes all cross-reacting antibodies, but does not remove the specific homologous antibody. By the use of this technique it can be readily determined if the agents are identical. This method has therefore come into use for the identification of newly isolated group B viruses. Of equal importance is the fact that this method makes possible determination of the degree of immunological overlap between two agents.

Limited electron-microscopic studies indicate that group B viruses are spherical particles. Recent biochemical studies with this group show that these agents can be inactivated by the proteolytic enzymes, trypsin, chymotrypsin; and papain. Clear evidence that the inactivation results from the direct action of the enzymes on the virus is a good indication that the virus particle is covered with a protein coat. The antigenic analysis, by antibody adsorption, is thus presumably the analysis of the protein coat. Proteases have no action on group A agents. It is therefore possible by biochemical means to show marked differences between group A and group B arthropod-borne viruses. It will be recalled that these groups were established entirely on immunological grounds."

TOXICITIES OF VARIOUS ACARACIDES TO MITES OF THE TETRANYCHUS COMPLEX IN EAST AFRICA

K. S. McKINLAY. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 219.

Under local conditions, particularly during dry periods or following the use of insecticides against other pests, cotton is liable to a heavy attack of spider mites belonging to the *Tetranychus telarius* complex. Damage to pyrethrum has also occurred. Since, in 1958, attempts to control an outbreak of mites on cotton at Arusha with parathion failed, and the entire crop was lost, the following series of screening tests was carried out.

Laboratory trials

Bio-assays: *Tetranychus* infested leaves were treated by dipping, for 5 seconds, in emulsion or wettable powder formulations of various insecticides. The petiole was passed through a notch in a cork into a 3" x 1" glass tube filled with water. Grease was applied around the petiole to prevent escape of mites from the lamina exposed to the air. After 24 hours the numbers of living and dead nymphs and adults on the lower surface of each leaf was counted using a binocular microscope.

In each test five different concentrations of the acaracide were used and at each concentration there were four single leaf replicates. Each acaracide was tested three times. Dosages and percentage mortalities were plotted on log-probit paper and the best line fitted by eye. The resulting L.D.50's were read off the graphs and are shown in the table.

PERCENTAGE OF ACTIVE INGREDIENT REQUIRED IN DIP TO GIVE 50% MORTALITY OF TETRANYCHUS TELARIUS ADULTS AND NYMPHS

Concentrate used	Trial 1	Trial 2	Trial 3
Metasystox 25% E.C.	0.00089%	0.00035%	0.00053%
Rogor 40% E.C.	0.00214%	0.00224%	0.00141%
Aramite 15% W.P.	0.00234%	0.00347%	0.00250%
Endrin 19.5% E.C.	0.25%	0.40%	0.20%
Dieldrin 18.5% E.C.	0.040%	0.040%	0.044%
Chlorbenzilate 20% E.C.	0.0061%	0.00125%	0.00083%
Malathion 50% E.C.	0.015%	0.018%	0.014%

Tests on potted plants: One foot high potted castor plants were infested with field collected Tetranychus from cotton, and a large population allowed to build up. When the mite population was high four plants were given a wetting spray 5 c.c. per plant, covering both upper and lower leaf surfaces, of 0.0125% Metasystox, and another four plants a similar spray of 0.0125% Rogor. Leaf samples were taken from the plants at intervals and the numbers of living and dead adults, nymphs, and larvae counted under a binocular microscope. Both Metasystox and Rogor were sufficiently persistent to continue killing for at least nine days.

Effect on eggs: Nine cotton leaves, maintained in 3" x 1" glass tubes, were each inoculated with ten adult females of Tetranychus. The female mites were allowed to lay eggs for twenty-four hours, and were then removed and the leaves treated immediately by dipping, for five seconds, in the following acaracides:- 0.0125% Metasystox, 0.0125% Rogor, control, (nil). After eight days the leaves were examined under a binocular microscope.

The results of the trial suggested that whilst neither Rogor nor Metasystox were ovicidal they were sufficiently persistent to kill larvae hatching from eggs laid as recently as the day before treatment. Therefore in the following field trials only single applications of the acaracides were made.

Field trials on cotton

Cotton plants approximately two feet high and planted singly at a six feet by six feet spacing to facilitate the spraying of single plant replicates were used. There were ten single plant replicates of each treatment arranged in randomised blocks, and the following compounds were applied as wetting sprays, (70 c.c./plant) to both upper and lower leaf surfaces.

Treatment A.	0.0125% Metasystox.
Treatment B.	0.0125% Rogor.
Treatment C.	0.1% Malathion.
Treatment D.	0.1% DDT.
Treatment E.	Nil control.

Leaf samples were taken twenty-four hours after spraying and the following percentages of all active stages present were found dead:- A. - 85%, B. - 85%, C. - 91%, D. - 3%, E. - 7%.

It was impossible to make actual population counts large enough to give statistically valid results so the overall results of the trial were assessed by grading the leaf infestation as nil, light, medium and heavy. The top five fully opened leaves on each plant i.e. 50 leaves per treatment, were examined on the day of treatment and at 7 and 18 days later.

Both Metasystox and Rogor were extremely effective and reduced the mite population to well below the level at which it could do the plants any harm. Although malathion gave a high initial kill it was neither toxic enough, nor persistent enough, to have any real effect on the size of the ultimate population of mites when only a single application was made. By the end of the trial the mite population on Treatments C, D, and E was so large that the majority of the leaves on the plants were turning yellow and shedding. Since the experiment was based on single plant replicates in randomised blocks it was possible for the plants given the more effective treatments to be reinfested from the surviving populations on the less effective treatments and the controls, and it is therefore fairly certain that on a field scale a single application of either Metasystox or Rogor would give effective control.

Field trials on castor

A small plot of castor, planted six feet by six feet, was infested with Tetranychus by placing field collected cotton leaves, bearing mites, on the castor plants. When the mite population had built up to a high level, and the plants were from three to five feet high, two rows were treated with 0.0125% Metasystox, two rows with 0.0125% Rogor, and two rows were left as an untreated control. The acaracides were applied as wetting sprays to both upper and lower leaf surfaces and approximately 200 c.c. of spray was applied to each plant.

Microscopic examination twenty-four hours after spraying showed that 79% of all active stages were dead on the plants sprayed with Metasystox, and 66% dead on plants treated with Rogor.

Leaf grading, as described in the cotton trial, was carried out after thirteen days. Results showed that Metasystox was superior to Rogor.

DISCRIMINATIVE INSECTICIDE SPRAYING AGAINST G. MORSITANS

K. S. HOCKING. Colonial Pesticides Research Unit, Tanganyika.
Miscellaneous Report No. 218. February, 1959.

An experiment was carried out in the Kabiganda valley in South Western Uganda to see if a residual insecticide applied to the putative resting places of Glossina morsitans in fly concentration sites would eradicate the fly.

The valley contains about seventeen square miles of woodland infested with G.morsitans and the fly concentration sites consist of groups of Acacia hebecladoides in association with one or more thickets. The treatment was the application of a dieldrin emulsion to the lower sides of the branches of the A.hebecladoides (or in one area to those of the associated thickets).

Six pairs of transect fly rounds, each pair enclosing a rectangle of approximately two square miles, divided the area into six blocks (A to F). Catches were carried out weekly from July 1957.

Spraying operations

The spraying of A.hebecladoides in Block D was carried out from October to December, 1957. As a comparison the thickets associated with A.hebecladoides were sprayed from January to March, 1958. The spraying of the thickets was more costly in time and insecticide than the spraying of the acacias and did not appear to be any more effective, the rest of the valley was therefore treated by spraying the A.hebecladoides only. Spraying was completed in November 1958.

Altogether about 11,000 acres of woodland were treated and about 1,300 gallons of "Dieldrex" were used. This works out at approximately one fifth of a pound of dieldrin per acre and gave a deposit of approximately 0.8 gram of dieldrin per square metre on the surfaces sprayed.

During the spraying of Block E, the persistence of dieldrin on the bark of Acacia hebecladoides was estimated chemically. Using an emulsion containing 3 per cent (w/v) of dieldrin, 20 trees were sprayed. Filter papers were used to obtain comparative measures of the initial deposits, and gave a mean deposit of 0.79 (S.D. ± 0.30) g per square metre. Bark samples, each of about 300 sq.cm, were removed at various time intervals up to 60 days after spraying. The surface deposits of insecticide were removed with light petroleum, and the insecticide that had been absorbed into the bark was then removed by extraction with hot petroleum for 8 hours. Stepanow reduction to total chloride and Volhard titration were used for estimating the amounts of dieldrin.

There was evidence that a small proportion of the insecticide was absorbed into the bark soon after spraying. There appeared to be no further absorption, and loss thereafter seemed to be largely by reduction in the surface deposit. The decrease was very slight during the first five days, but thereafter appeared to be logarithmic with time. Expressing rates of deposits on the bark as percentages of the rates of deposits upon the paper samples taken during the spraying, the regression equation for the loss with time after five days was:-

$$x = 85 - 36 \log_{10} (t-5)$$

where x is the deposit washed off the bark, expressed as a percentage of the initial deposit upon the sample papers, and t = time in days after spraying. This means that 90% of the insecticide disappears from the surface of the bark in about 4 months and 100% in about 8 months. It is probable that 10% of the original deposit is quite sufficient to be lethal on long contact.

Entomological results

Examination of the fly round catches showed that the overall apparent density (A.D.) was reduced from about 33 to less than 1; and half of the residual apparent density is due to a fly round in Block A (the last to be sprayed) where the lethal effect of the insecticide still remains and a further reduction can be expected. However it appears that a small population of G.morsitans remains in the valley and that the application of the insecticide has not succeeded in eradicating the fly from this area.

Costs

The costs of this experiment were as follows:-

1,300 gallons of Dieldrex @ Sh.52/50 per gallon =	£3,400
Labour costs for spraying operations	£500
Entomological staff	£180
Transport costs	£630
Salary of supervising Field Officer	£840

The cost of the actual spraying operations was therefore about Sh.8/- per acre.

NIGHT OBSERVATIONS ON *G. SWYNNERTONI* AUST.

H. A. W. SOUTHON. A paper presented at the 7th Meeting of the International Scientific Committee for Trypanosomiasis Research, held at Brussels, 25-30 August, 1958.

Previous attempts to study the night resting sites of *Glossina swynnertoni* Aust. have been made by marking tsetse with fluorescent paint and using ultra-violet light to locate the marked flies. (Jewell, 1956 and 1958). In March 1958, investigations were carried out to discover whether the reflection of visible light by small glass spheres could be employed as an alternative to the above method. The spheres, of diameters 0.10 to 0.40 mm were applied to the tacky surface of a spot of artists' oil paint on the thorax of the tsetse. The method was found to be successful and 6-volt torches provided an adequate light for the location of the flies in the field. The development of this method has been reported by Rennison et al. (1958) working in Uganda.

Night observations are recorded, both on marked and wild unmarked flies in an area of thornbush, Shinyanga, Lake Province, Tanganyika Territory, during the long rains. The flies were found to move at dusk from diurnal resting sites on the undersides of branches, to perch on leaves at night and to return to branch resting sites at dawn.

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REPORT ON CHLOROPHORA

E. W. JONES. Colonial Office. H.M.S.O.

The psyllid bug, Phytoloma lata, causes a gall which appears to be crippling in its effect, and one of the principal obstacles to growing Chlorophora. Nevertheless opinion as to its importance differs widely. The fundamental obstacle to the use of insecticides has been the protection offered by the gall throughout most of the insect's life. However, a systemic insecticide was tried in about 1953 in the Belgian Congo. Folidol E.605 (parathion) sprayed at intervals of 15 days prevented the formation of galls. With a concentration of 0.01% Folidol a few galls were formed (21 galls on 6 plants out of 400 as compared with 1,470 galls on 209 plants out of 400 in controls), but with higher concentrations (0.03% and 0.06%) no galls were formed.

Further experiments have been made in the Congo with Folidol and with Systox and Hanane. Hanane killed only 47% of the existing galls; spraying with Systox and Folidol was 'completely effective'. Weekly watering with 0.1% Systox also prevented attack.

Five proprietary insecticides (Basudene, Chlorothion, Metasystox, Bayer's 8215, and Folidol) in a range of concentrations were tested at Elundu in 1955; all were reasonably satisfactory, Folidol proving as good as any. It is apparently not transported sufficiently within the plant to protect parts remote from those which receive the spray. Systox, though more mobile, has proved less satisfactory in practice.

M. Gaillez finds that a 0.1% solution of Folidol is liable to damage plants, while a 0.03% solution permits growth of a few galls; a 0.05% solution applied once a fortnight is satisfactory.

COTTON PEST RESEARCH SCHEME, QUARTERLY REPORT FOR OCTOBER-DECEMBER, 1958

Gatooma Research Station

Diparopsis Control

A trial has been laid out to assess the relative efficiency of endrin, Sevin and DDT (+ aphicide if necessary) in controlling cotton insect pests. As an extension of this trial the same treatments are being applied to cotton plants which will be artificially infested with Diparopsis eggs at intervals before and after spraying. The efficiency of the treatment will be assessed from the number of 1st instar larvae successfully penetrating buds and bolls.

In another trial the efficiency of seed treatment or an early spray in preventing tip boring is being assessed. The insecticides being used are Rogor and endrin, at 0.25 lb. in 10 gal. water/acre, and Thimet 44D at 5 and 10 lb./100 lb. seed. These treatments are to be followed by 8 routine applications of 0.25 lb. endrin in 10 gal. water/acre.

Makanga

Dysdercus Control

An experiment was commenced at the end of December to test the efficiency of dieldrin and chlordane against Dysdercus on S.africana. As in last season great difficulty has been found in finding suitably infested hosts for treatment and control.

Other Pests

The only insect that has done noticeable damage to any seedling cotton is Hodotermes mossambicus, although aphids are common in some fields - considerably commoner than in previous seasons. H.mossambicus is also commoner than usual but has done only local damage. Zonocerus elegans is considerably less common than in the previous season in most areas and has done very little damage indeed to the cotton to date.

Irrigated cotton on Makanga Farm has shown good growth but there has been surprisingly little insect damage to date, apart from Diparopsis, and virtually no jassid attack although many of the plants are flowering or bolling - although quite severe jassid attack has occurred on the groundnuts. A few Dysdercus adults found their way to this irrigated cotton towards the end of November, but the numbers have remained low on all fields. Sevin at half a pound to the acre is being used on one of the irrigated cotton fields to observe its effectiveness against insect pests in general.

Chitala (Nyasaland)

A preliminary insecticide trial is being carried out at the Chitala Experiment Station this season, to assess the effect of endrin in controlling cotton insect pests, particularly Diparopsis and to determine whether there are differences in response to endrin treatment between rain-grown cotton at Chitala and at Gatooma: 8 weekly applications of endrin will be made from the commencement of bollworm attack, each at the rate of $\frac{1}{4}$ lb. active ingredient in 10 gal. of water per acre.

PROCEEDINGS OF THE 1957 MEETING OF BRITISH WEST INDIES SUGAR TECHNOLOGISTS

Pest Control Measures

Antigua: The only important pest of sugar cane in Antigua is the small moth borer, Diatraea saccharalis. To combat the moth borer the Cuban fly parasite, Lixophaga, was liberated in quantity in 1932, and it was early found that Lixophaga controlled the damage caused by this pest. There is some doubt as to whether or not Lixophaga is established in Antigua, and liberations of the parasite have been made annually since 1932.

(Sugar Estate Agriculture in Antigua. P.E. Turner. pp.85-92).

British Guiana: Drift dusting of BHC with power blowers for control of adult froghopper (Aeneolamia) was discontinued by 1950, as it was realised that poor control was resulting. From this date, insecticide applications have been made either by hand dusting or spraying or by aerial application. Numerous proprietary dusting machines have been tested, but without exception all have failed through mechanical defects after a short period of field use. Hand dusting has been largely replaced by pressurised knapsack sprayings, but where it is necessary, e.g. stool dusting for froghopper nymphs, it is carried out by simple hand spreading of the insecticide. BHC or dieldrin application for routine froghopper/hardback control are now largely carried out by aircraft at rates down to 6 pints/acre.

BHC is still the most commonly used insecticide. All requirements fur dusts are made by 100 mesh limestone dilution of 14% gamma material. Depending on cane density, application varies between 2 cwt. and 4 cwt./acre. Dieldrin application (aerial or hand sprays) of 1 lb./acre active material have given excellent control of caterpillars (Laphygma) in young cane, and has also been successfully used in irrigation water for control of hard-back beetles (Dyscconetus sp.) Malathion, at rates of 2 lb./acre has given excellent control of sporadic outbreaks of the yellow cane aphis (Sipha flava). For this work, where underleaf coverage is essential, power sprayers (Motoblo Fontan) have given good results at dosages as low as 8 gal./acre.

Chlordane: considerable yield increases have been reported from Louisiana, India and other cane growing regions from soil applications of this and other insecticides. Improved germination and yields in these cases have been attributed to control of small soil insects (Collembola etc.) which feed on the young cane rootlets, and which are not generally recognised as major pests. Several "soil insecticide" experiments have been laid down to determine the effects of such insecticides under local conditions. Aldrin, BHC, chlordane, DDT and dieldrin in both dust and spray formulations applied at or soon after planting, have been tested in 10 replicated layouts. Application rates varying between 1 lb. (dieldrin and BHC) and 25 lb. (DDT) per acre were used. In only two cases have significant yield responses resulted, both with dieldrin at 2 lb. actual/acre. In all other plots, no significant yield responses were noted and, particularly in the chlordane series and higher (2 and 4 lb./acre) BHC plots, significant yield reductions of up to 8 tons cane/acre resulted.

The principal pest of sugar-cane is the yellow-headed moth borer, Diatraea canella which is responsible for over 90% of the total damage due to the genus. In trials against Diatraea, foliar sprays of endrin and BHC (0.1 lb./acre) were made at fortnightly and monthly intervals. Counts were made of the number of dead hearts in all plots at these intervals, and a final joint infestation count was made. All treatments reduced infestation by some 15% (dead heart counts) but there were no significant reductions in final joint infestations.

The use of pelleted thallium sulphate baits for rat control has given good results and is being extended. Rat preference for the whole grain type of bait has been definitely established.

(Developments in Weed and Pest Control in Sugarcane in British Guiana. J.F. Bates. pp.100-104.)

St. Kitts: The major insect pest of sugar-cane in St. Kitts is the small moth borer, Diatraea saccharalis. In 1932, the Cuban fly parasite, Lixophaga diatraea, was introduced into St. Kitts from Cuba. For eighteen months a highly intensive campaign was pursued, during which Lixophaga were released throughout St. Kitts. Lixophaga at once became established and no further releases have been necessary. The success of the control is shown by the fact that joint infestation by borer dropped from 20.9% in 1933 to 7.7% in 1935. The infestation since 1935 has averaged 5%.

(Sugar-Cane Agriculture in St. Kitts. J.J.E. Mestier and P.E. Turner. pp.80-84.)

Trinidad: The most successful control measure to date for sugar-cane froghopper, Aenolamia varia saccharina, consisted of the application to trashed stools of a 5% BHC dust before or at the time at which the first brood nymphs appeared. This gave a good kill of the nymphs already present while the BHC had sufficient residual effect to kill the remainder of the first brood as they emerged. By and large one dusting was sufficient to control the pest for the season. However, in 1954, nymphs in certain areas began to show resistance to BHC and to the other chlorinated hydrocarbons. Since then, the area in which the nymphs are resistant has increased rapidly, until on one producer's property on only 32% of the area can control still be obtained with BHC. On the remaining land a 3% malathion dust is used as a root dust. This gives a good immediate kill but has no residual effect necessitating repeated and costly applications. Even then, when the cane becomes too big to make root dusting possible, the adult population builds up to damaging proportions and further measures have had to be taken to destroy the adults. These measures involve foliage dusting with 3% malathion dust applied either by powered shoulder mounted machines carried through the fields or by large tractor towed Messinger dusters capable of "blanketing" fields from the traces. Foliage dusting gives a good kill of adults present at the time of dusting but has no effect on those emerging later. Thus fields have to be repeatedly dusted.

In a recent root dust trial 2% Trithion and 3% malathion dusts at $2\frac{1}{2}$ cwt. per acre have been compared. Four stools were selected at random in each plot, the nymphs present in and around these being counted before application of the treatments and at intervals afterwards. Analysis of data showed that the treatments were applied towards the end of one brood of nymphs and that the next brood began to appear around 18 to 20 days later.

While the malathion gave an immediate kill, reducing the population to 1% of its original level in one day, by the time the new brood appeared its effectiveness had worn off allowing a rapid build-up in population. The Trithion, however, gave a much slower initial kill but maintained the population at a very low level throughout the period of the trial. It cannot yet be said over what period the Trithion will remain effective but this trial shows that it has a residual effect lasting, at the rate of application used, for at least 40 days. It is considered that the rate at which the Trithion was used in this trial was excessive and a further trials has been laid out using lesser amounts.

(A Note on the Use of Trithion in Froghopper Control. D.J.H. Neate. pp. 190-192.)

WEST AFRICAN INSTITUTE FOR OIL PALM RESEARCH
SIXTH ANNUAL REPORT 1957-1958

Cercospora Leaf Spot

Nurseries received regular spray applications at three weekly intervals using Perenox at 1 lb: 100 gal. of water. At this strength very little copper burn was apparent and a good measure of control was achieved. All 1957 field plantings received the same treatment. Although these seedlings were infected when planted out into the field a fair amount of control was achieved. During December it was observed that some of the 1956 field plantings were severely infected with Cercospora. All badly infected leaves were removed and the seedlings were sprayed. The cost of both pruning and spraying was approximately ten shillings per acre.

Effect of "Stickers" on the Redistribution of Spray Deposits

The results of experiments, using the plaster of Paris technique, show clearly that spray deposits of Perenox, ziram and thiram are unstable when applied without the addition of stickers. Impressions of the upper surface of the leaflets show that under conditions of heavy rainfall there is a general tendency for fungicidal deposits to move on the leaflet surface towards the main vein and the lower edge of the leaflet. As migration proceeds, the spray residues are washed towards the base and the tips of the leaflet and thence to the soil. The lower surface of the leaflets are not usually subjected to the direct impact of rain, but spray deposits are redistributed by rain splash and by rain which passed from the upper surface to the lower surface as a water film. The addition of stickers greatly stabilizes those fungicides tested and the rate at which spray deposits are removed from sprayed leaflets is markedly reduced.

GLASSHOUSE CROPS RESEARCH INSTITUTE.
ANNUAL REPORT FOR THE YEAR 1957.

Red Spider Mite, Tetranychus urticae Koch (= telarius L.)
(N.W. Hussey and W. J. Parr.)

It is concluded from studies of the colour complex in this species that there are two forms, reddish-brown and green, which should be regarded as sub-generically distinct. When testing acaricides, therefore, only pure inbred lines should be used.

Control of Aphids with Fluoracetamide (V.A. Gentle.)

Experiments have been carried out with fluoracetamide, used both as a fumigant and as a systemic insecticide. Lettuces were used as test plants but fluoracetamide is not recommended for commercial use on lettuce because of its toxicity.

Fumigation tests were carried out against Aulocorthum solani, A.circumflexum and Nasonovia ribis-nigri. Good control of aphids was obtained at certain concentrations, which ranged from 1.4 g to 0.21 g/1000 cu.ft. and temperatures (59°-63°F) but in some cases damage to the plants resulted. Used systemically by watering solutions on to plants a good kill of Nasonovia was obtained after 3-4 days with concentrations of 1:1000, 1:2000, and 1:4000 (equivalent to 28, 14, and 7 p.p.m. in the soil) at 60-65°F and low atmospheric humidity, but the plants showed phytotoxic effects. At 50-55°F and a higher atmospheric humidity concentrations of 1:1000 to 1:16,000 produced no phytotoxic effects but even the highest concentrations failed to control the aphids. It is assumed that at the lower temperature and higher humidity the uptake of fluoracetamide was insufficiently rapid to produce a lethal concentration within the plants.

FUNCTIONING TRIALS ON THE S.A.6 SPRAY INSTALLATION FITTED IN THE DRAGONFLY HELICOPTER.

R.F. HILL. Colonial Pesticides Research Unit, Porton.
Report No. 159.

For an account of previous trials see P.A.N.S., 3, (4), pp. 291-2.

Further trials were carried out to ascertain the speed and height at which the spray produced by the S.A.6 Spray Installation might be effective for penetrating foliage. The liquid sprayed was G.P.Fog Oil dyed with 1% Waxoline Red. Incorporation of modifications, unconnected with spraying necessitated the removal of the starboard insecticide tank and mounting, reducing the capacity from 65 to 30 gallons (i.e. 300 lb.).

Previous experience had indicated that to obtain a good distribution of the spray with the boom originally designed for the Dragonfly, it was desirable to blank off jet position No. 1 on the starboard side of the boom and positions Nos. 1-5 inclusive on the port side. Accordingly the opportunity was taken to fit a new spray boom which had 24 jets spaced at 6" centres instead of 8.5" thus leaving the centre 6'2" of the boom clear.

In preliminary trials a cine-camera was used to record the appearance of the spray at various heights and speeds. Examination of the films showed that at speeds in excess of 30 knots and heights above 30 feet, a large amount of the spray cloud drifted out of the sampling area. Subsequent trials were confined to these limits. Contamination in the sprayed area was estimated from jump cards placed vertically, 18 in. from the ground and horizontally, 12 in. from the ground.

Results showed that at a height of 8 ft. there was a measurable quantity of spray deposited on the under surface of the horizontal cards and the reverse face of the vertical cards at all speeds from 11 to 25 knots. At a height of 10 ft. the amount of spray deposited on these surfaces was considerably reduced when the aircraft speed was 20 knots or more. An increase in operating height to 20 ft. also caused a reduction in the amount of spray deposited on the reverse sides of the cards at speeds of 14 and 20 knots. When operating at heights of less than 10 ft. and at a true air speed of 10 knots or less, a large amount of spray contamination of the helicopter took place.

REVIEW

ROLE OF SURFACTANTS IN PEST CONTROL

D. J. COLWILL. Colonial Pesticides Information Service. April, 1959.

A glance through the accompanying glossary summarised from data provided by manufacturers will suffice to indicate the diversity of surface active substances that are now available to assist in the formulation and application of pest control chemicals.

Many years have passed since the opportunity was first taken by agriculturalists to utilise the physico-chemical attribute of surface activity, inherent in materials possessing the determinate molecular structure. Originally, soft soap was used as a wetter and spreader for improving the performance of nicotine washes, and the results were encouraging. Before use it required to be boiled with a suitable quantity of water so that it is not surprising that it was readily superceded by sulphonated lorol - one of the earliest synthetics - which had merely to be added as a powder to the spray at some 6-8 oz. per gal. and was, moreover, unaffected by hard water and compatible with sprays based on lime sulphur, lead arsenate, derris and nicotine.

With the rapid development in recent years of new surfactants, and the introduction of more versatile insecticides, fungicides and herbicides, numerous recommendations for their joint use have appeared. Although the accent has mainly been on the utilisation of surfactants for the formulation of pesticides as dispersible powders, seed disinfectants and, particularly, emulsifiable concentrates (16), recent trends signify a desire to obtainea better understanding of the function of the surfactant in modifying the wetting, spreading, penetration or adhesion of spray deposits, in terms of its chemistry, properties and use under field conditions, (1), (5), (9), (11), (13), (14), (15), (17). It has become evident that the correct inclusion of a surface active compound may well improve spray effectiveness in one or more of the following ways:-

Wetting Power. The spray liquid is better able to wet the surface to be treated which can be that of an insect or fungus or plant (fruit or foliage). These surfaces are frequently lipoid in character and therefore water repellent to aqueous sprays.

Penetration. Closely allied to wetting effect is the ability of a surfactant to increase the rate of penetration of spray material, as for example, the absorption of contact insecticides via the insect cuticle or a systemic chemical by plant tissue. The penetration of the dense, hairy layer of *Salvinia auriculata* also that of *Pistia stratiotes* which previously resisted the passage of spray droplets has been accomplished by addition of surfactant.

Retention of Spray Droplets. Correct use of surfactant should eliminate the rebound of droplets observable on non-wettable foliage, (e.g. pea and flax) with insufficiont surfactant; whereas, if, too high a concentration is used on easily wettable foliage (e.g. potato, broad bean) the droplets may coalesce and run off.

It is becoming increasingly evident that surfaces (particularly those of different plant species at different periods of maturity) vary greatly in their retention ability. This effect appears to be governed closely by the contact angle formed between each droplet and the treated surface.

Apart from the increased spraying economies that may be affected by efficient droplet retention, Byass (2) has indicated that it is not necessary for the whole of a plant surface to be covered to kill static or mobile insects and maintains that a fine, uniform particulate deposit covering as little as 5% of the crop surface can be effective with many of the contact pesticides.

Spray Cover. The influence of the surfactant on the dispersion and distribution of the droplets is therefore noteworthy, and a surfactant may, in fact, modify the spray characteristics at the nozzle orifice, with the production of a finer spray and possibly a redistribution of the droplets across the spray width - a higher proportion being directed nearer the centre.

Problems Governing the Use of Surfactants

The effects noted above are particularly associated with the true wetting type surfactants, and it is necessary to ensure that these will be compatible with the other constituents of a spray, otherwise their full benefit will not be realised. Phytotoxic injury (leaf scorch) has been reported as a deleterious side effect (3) and is considered more likely when anionic and cationic wetting agents are used. Hartley (4) has remarked on the lowered persistence of deposits that results through finer spreading and suggests that a compromise must be reached.

There is also the difficulty of evaluating the effect in nature of a surfactant. Correlation between laboratory and field tests is, at present, not satisfactory, because of the several factors involved. Stanley (14) remarks that surface tension and spreading measurements are insufficient to predict likely field performance and that a knowledge of the rate at which adsorption of the wetter will take place at freshly formed surface during spray generation (involving measurements of surface changes of milliseconds duration!) is necessary. Thompson (15) investigating the wetting of apple, pear and cabbage leaves reports that the best correlation is that given by the Draves sinking time test.

Some Practical Results

Leach (7) reports that the standard of leaf spot control has been considerably improved throughout Jamaica by the addition of Triton X 114 to the standard Bordeaux mixture. Its ability to cover the highly waxed underside of the youngest leaves and to leave a spray deposit, clearly. visible from the ground, is specially praised. Triton X 114 used by Robertson (10) as a "sticker" in spraying trials against freckle leaf disease of oil palm seedlings in Nigeria, was shown to improve greatly the initial retention of the fungicidal spray deposits and to limit their subsequent removal by rainfall.

Mapother (8) working in N. Borneo on means of increasing the effectiveness of aphicides against Pentalonia nigronervosa, the aphid vector of bunchy top disease of abaca, found that with Manoxol N at 0.05%, complete wetting was obtained, particularly of the last emerging leaf, at all stages of opening, which is a main aphid site and more difficult to wet than others.

Zeumer and Neuhaus (17) investigated the effect of spray supplements on the wettability, resistance to rain and suspensibility of insecticidal and fungicidal sprays. They showed that a wetter of the polyglycolester type generally increased wettability without adversely affecting the other physical properties or causing flocculation.

Experiments conducted by Schneider on the addition of surface active agents as additives in herbicidal sprays indicated that penetrability, as distinct from wetting, was an important factor in increasing the rate of effect of slow acting chemicals, e.g. 2,4-D and trichloroacetic acid.

The penetration efficiency of oil sprays is well established. (12) Recently, water in oil (invert) emulsions have been produced which are claimed to afford better penetration and resistance to rainfall than the conventional O/W emulsions. (6) Invert emulsions may contain 10-15% oil, consisting of water droplets surrounded by oil. They are viscous and sticky and remain visible on sprayed surfaces after application until break of the emulsion occurs (approx. 1-2 hours). Their low drift character is of particular interest for low volume applications from the air.

Forecast

It is apparent that this topic, one of growing complexity and importance, can provide a fertile sector for research, at least for chemist, botanist, physicist, mycologist, entomologist and agronomist.

With regard to the practical implications of developments-to-be it seems probable that the conventional all-purpose formulations will gradually be supplemented by "tailor-made" preparations.

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GLOSSARY OF PEST CONTROL SURFACTANTS (Available in the U.K.)

Product	Key	Indications of Manufacturer
ABRIL BPK'L	2	Light brown fluid of a paste-like consistency. Oil-in-water emulsion promoter. Forms clear solutions in water and is soluble in most types of organic liquid. The pH of dilute aqueous emulsions is 8-9; their stability range is 7-11.5.
ABRIL OWT	2	Brown liquid, O/W emulsifier. Less soluble in water than BPK'L and gives a cloudy solution at moderate concentrations. Soluble in most organic liquids and suitable for use with waxes, oils and olein. The pH of dilute aqueous emulsions is 8-9; their stability range is 7-11.5.
ABRIL PDS	2	High melting point wax (mp 165°C) of average particle size 5 to 15 microns, possessing good suspending power for oil based pesticides.
AEROSOL OT	12	See MANOXOL OT.
AGRAL 90	23	Nonionic ethylene oxide condensate of an alkylated phenol. It is a mobile, amber coloured liquid, miscible with water to form a solution which is stable to the addition of alkalis, organic and mineral acids, many metallic salts and to hard water. Used as a wetting agent in agricultural sprays.
AGRAL LN	23	A diluted form of AGRAL 90 (q.v.).
AGRILAN A	18	Blended anionic/nonionic emulsifying agent. Recommended especially for emulsification of toxaphene and chlordane, or in conjunction with Ethylan LD and Ethylan TU (q.v.) for the emulsification of DDT, BHC, aldrin, dieldrin and phenoxyacetic acid esters in all types of solvent, and DNCC in aromatic solvents.

Product	Key	Indications of Manufacturer
AL SERIES	16	Products at present available in development quantities only. Fatty alcohol condensates with ethylene oxide. Nonionic. AL 5. Speculative emulsifying agent, of possible interest as a wax emulsifier. AL. 9. Speculative emulsifying and antistatic agent. AL 14. Speculative emulsifying and antistatic agent. AL 18. Speculative emulsifying and antistatic agent. AL 30. Emulsifying agent. AL 45. Emulsifying agent.
AMINE 220	29	1-hydroxyethyl-2-heptadecenyl glyoxalidine. Liquid cationic,sp.gr. 0.9330;b.p. 235°C (1 mm); Flash point (open cup) 465°F. Soluble in mineral and vegetable oils, in dilute solutions of mineral acids, in common organic solvents, and is slightly soluble in water. Aqueous solutions are alkaline - pH, (2% solution), 10.8. Forms salts with acids. Its aqueous dispersions possess cationic surface activity that is greatest under acid conditions, in contrast to soaps, which are decomposed by acids. The commercial product contains about 90% of the cyclic glyoxalidine, the balance being the linear amide of oleic acid and aminoethyl ethanolamine. The outstanding property of Amine 220 and its salts is their ability to emulsify diesel, mineral, and vegetable oils, and pyrethrum and phenothiazine concentrates.
AMINE HPL	11	Stearin dimethylamine 100%. Water dispersible, oil soluble amine, for emulsifying purposes.
AMINE OL	11	Olein dimethylamine 100%. Water dispersible, oil soluble amine, for emulsifying purposes. Both amines HPL & OL are stated to possess herbicidal properties towards grass and to be suitable for controlling termites.

Product	Key	Indications of Manufacturer
ANSA	20	Alkyl naphthalene sulphonic acid. Thick brown, strongly acid liquid. Active matter, 70% min. Water content, 22% min. (approx.) Free sulphuric acid, Balance. Useful spreader for agricultural sprays containing mineral acids.
APHROSOL FC	16	Solution of sodium alkylnaphthalene sulphonate. Anionic, neutral, brown coloured clear liquid, readily soluble in hot or cold water. Wetter and sticker in the preparation of pest control products.
AP SERIES	16	Products at present available in development quantities only. Alkyl phenol condensates with ethylene oxide, Nonionic. AP. 1. Solubiliser for products with longer ethenoxy chain. AP. 5. Emulsifying agent. AP. 6. Effective emulsifying and wetting agent for use in formulating pest control products. AP.14. Effective emulsifying and wetting agent for use in formulating pest control products. AP.25. Good wetting agent for use in phosphoric acid solutions.
ARMACS	3	Cationic emulsifiers based on the acetic acid salt of fatty amines; of the general formula $(RNH_3) + (CH_3COO) -$ where R represents an alkyl group derived from fatty acids ranging in chain length from 8 to 18 carbon atoms. The 18 carbon chain may be saturated or unsaturated. The chain length and degree of unsaturation largely regulate the solubility behaviour of these chemicals in oil and water systems.
ARMEENS	3	High molecular weight, primary and secondary aliphatic amines displaying cationic surface activity. Pigment grinding, softening and dispersing agents. The higher fatty amines are essentially water insoluble but upon neutralisation with acetic acid or hydrochloric acid with warming a water-dispersible

Product	Key	Indications of Manufacturer
ARMEENS (Contd.)	3	salt is formed. The eight and ten carbon chain amines exhibit some water solubility in their unneutralised form. The amines themselves are soluble in alcohol, benzene, cyclohexane, chlorinated solvents, ethyl ether, ethyl and butyl acetate, and mineral spirits. Amines possess the ability of changing surfaces from water-accepting to oil-accepting - even in the presence of water.
'ARQUADS'	3	Quaternary ammonium salts. Use Arquad 2 C in conjunction with Ethofat 142/20 (q.v.) for preparation of emulsifiable concentrates.
ARYLAN CA	18	Anionic emulsifying agent containing 70% active calcium salt of dodecyl benzene sulphonate. It is a brown, viscous liquid with a flash point of 95°F - 105°F (35°C - 40°C). The water content is less than 1%. This product is oil soluble and is designed specifically for use in conjunction with Ethylan BV (q.v.). The combination of the two products provides, for a very wide range of toxicants and solvents, an emulsifier system able to perform equally well in cold or warm, hard or soft water at low concentrations.
ATLOX 3335	14	Alkyl aryl sulphonate blended with polyoxyethylene sorbitan esters of mixed fatty and resin acids. Clear to hazy brown liquid of sp.gr. 1.05 at 25°C; pH, 10% disp. H_2O, approx. 8; HLB = 13; Flash point approx. 106°F. Water content 0.5% max. Soluble in most insecticide and herbicide concentrates and aromatic solvents. Insoluble in kerosene and paraffinic oils. Its use alone or in combination with Atlox 8916P or Atlox A 52 (q.v.) is suggested with aldrin, aramite, BHC, BHC/DDT, butyl and isooctyl esters of 2,4-D, 2,4,5-T, chlordane, DDT, dieldrin, heptachlor, heptachlor/DDT combinations, lindane, methoxychlor, parathion, strobane, TDE, thanite, toxaphene, and toxaphene/DDT combinations.

Product	Key	Indications of Manufacturer
ATLOX 8916 P	14	Polyoxyethylene sorbitan esters of mixed fatty and resin acids. An emulsifying assistant to use with Atlox 3335 (q.v.) Red brown, oily liquid of sp.gr. approx. 1.1 at 25°C. Insoluble in aliphatic oils; pH 10% disp. H_2O approx. 7; HLB 14.6. Acid number 1 max; Hydroxyl number 100-130. Viscosity cp at 25°C 1100-1300; Water content 1.0% max.
ATLOX A 52	14	Sorbitan mono fatty acid ester. An emulsifying assistant for use with Atlox 3335. (q.v.). Dark red viscous oily liquid (will gel on standing) of sp.gr. approx. 1.0. Soluble in aliphatic and aromatic solvents. Dispersible in distilled water. HLB, 4.3; Acid number, max.7; Saponification number, 145-160; Hydroxyl number 160-185. Water content 0.5% max.
BEROL EMU-01	32	Nonionic emulsifier of polyethylene glycol ether type (100% active). Yellow-brown liquid which changes to a waxy consistency at low temperatures. Soluble in alcohols, acetone, fats, chlorinated hydrocarbons, benzene, xylene etc. and dispersible in water. An incomplete solubility in different oils may often be improved by the addition of polar solvents such as acetone, alcohols etc. Stable in acid and alkaline media and compatible with all classes of surfactants. Suitable for the formulation of emulsifiable concentrates containing such as DDT or chlordane in a mineral oil carrier (e.g. diesel oil or white spirit). It is suggested that trial blends should start with surfactant concentrations of 5-10%.
BEROL EMU-02	32	Nonionic emulsifier of the alkyl phenol polyglycol ether type, (100% active). Yellow-brown viscous liquid which changes at -7°C to a waxy consistency. Soluble in alcohols, acetone, fats, trichlorethylene and aromatic solvents and dispersible in water, white spirit, paraffin oils and mineral oils. An incomplete solubility in

Product	Key	Indications of Manufacturer
BEROL EMU-02 (Contd.)	32	an oil can often be improved by the addition of Berol EMU-04 or a solubilizing agent such as a fatty alcohol, isopropyl alcohol etc. Stable in acid and alkaline media and compatible with all classes of surfactants. Suitable for the formulation of emulsifiable concentrates based on mineral oils containing chlordane, pyrethrum/piperonyl butoxide, 2,4-D, 2,4,5-T.
BEROL EMU-09	32	Nonionic emulsifier of alkyl polyglycol ether type. Yellow viscous liquid that becomes waxy at 5-6°C. Soluble in warm and cold water, acetone, alcohols, fats, benzene, cyclo-hexanol and trichlorethylene. It is insoluble in paraffin oils and mineral oils. In these cases solubility can often be obtained by the addition of Berol EMU-04 and if necessary a small amount of water. Stable in acid and alkaline media and unaffected by hard water and other surfactants under usual conditions. Forms O/W emulsions with fats, waxes and mineral oils. Suitable for formulating emulsifiable concentrates, e.g. chlordane, parathion, malathion in mineral oil solvents; aramite, lindane, aldrin or dieldrin in xylene; 2,4-D and 2,4,5-T in mineral oil mixtures.
CAISOLENE OIL HS	16	Aqueous solution of the sodium salt of a highly sulphated oil. Anionic, neutral, golden yellow coloured liquid readily soluble in cold and hot water in all proportions. Solutions are stable to dilute mineral and organic acids, alkalis, hard water and many salts. Primarily used as a wetting agent.
CASA 57 EF	28	100% active cationic emulsifier for waxes. Compositions formed by melting together Casa 57 EF (10-20%) with paraffin wax are crystal clear when hot, cooling to hard, homogeneous waxes. These mixtures can be easily emulsified in boiling water to yield fine milky suspensions. Casa EF is a very pale coloured soft solid wax which melts to a crystal clear, light orange liquid.

Product	Key	Indications of Manufacturer
CASA 58 EF	28	100% active cationic emulsifier for oils. 2-5% in oils yields an easily emulsifiable oil in water emulsion. Casa 58 EF is a pale coloured, clear thick viscous oil.
CASA 51 LR	28	100% active cationic wetting agent. Thick viscous liquid forming clear solution with water or dilute acids. High surface active efficiency. pH (water) 7-9. Cationic oil or wax emulsions can be efficiently prepared by emulsifying the oil or wax into the water solution of CASA 51 LR. The best emulsions are prepared by mixing the oil or wax with CASA 57 EF or CASA 58 EF and this mixture should be emulsified into the acidified or non acidified water containing 51 LR.
CASA 61 LR	28	100% active cationic wetting agent. Viscous light brown clear liquid soluble in water and dilute acids to form clear, foaming, highly surface active solutions. pH (water) 6-7.
CASA 121 LR	28	100% active cationic. Soft, pale coloured, waxy material melting by slight warming to a crystal clear orange liquid. Soluble in water and dilute acids. It is especially useful as the wetting agent for cold acid solutions where good colour and high surface activity are required. pH (water) 6-7.
CASA 181 LR	28	100% active cationic. Clear, thick liquid soluble in water and dilute acids. It has good cold acid fastness. pH (water) 7-9.
CASA 181 ALR	28	Cationic wetting agent (100% active). Soft viscous resinous material melting easily to a clear liquid. It can be diluted easily to a 10% crystal clear solution for use as a stock solution. It has the highest acid fastness of all surfactants in the Casa LR. series. pH (water) 7-9.

Product	Key	Indications of Manufacturer
CIRRASOL OD	16	Deodourised brand of Lissolamine A 50% Paste (q.v.) in more dilute form. Active ingredient is cetyl trimethylamine bromide. Cationic, cream coloured paste.
CITHROL A	8	Nona ethylene glycol mono-oleate. Brown fluid of slight odour sp.gr. 1.02 at 15.5°C. Sap value 92.7 mg; moisture 0.3%; acidity as oleic 1.36%; pH 6.9; flash point 215°C. Dispersible in cold water. Soluble in white spirit (hazy). Completely soluble in xylol, ethyl acetate, meths, oleic acid and arachis oil. Powerful nonionic emulsifier of the O/W class, for oil fats, waxes and other materials. For use in agricultural and insecticidal sprays.
COMPROX A	4	A synergistic blend of anionic and nonionic surface active agents in liquid form. An aqueous solution suitable as a wetting agent and emulsion stabiliser in aqueous systems. Reaction neutral (pH : 7.5/8.0).
COVERITE	21	Aqueous solution of alkyl aryl polyethylene oxide condensate. Nonionic, neutral, non-staining and non-tainting. Compatible with all types of spray chemicals. Effective as wetter and spreader especially on waxy foliage (bananas, brassicas, onions, etc.) at 0.05% concentration.
CREXATOL C 100	24	Alkyl aryl polyglycol ether based on octyl cresol (100% active). Pale amber viscous liquid, slight odour, anhydrous, nonionic, wetting, spreading and emulsifying agent. Readily soluble in alcohols, fatty acids, vegetable oils, waxes and aromatic hydrocarbons. Miscible with water in all proportion. Soluble with coupling agent in aliphatic hydrocarbons. Stable over wide pH range. May be used in strongly acidic, alkaline or neutral aqueous or non-aqueous systems. Compatible with anionic and cationic type surfactants.

Product	Key	Indications of Manufacturer
CREXATOL C 100 (Contd.)	24	Use as a wetter at $\frac{1}{4}$-$\frac{1}{2}$ lb. per 100 gal. pesticidal spray (0.25-0.5% with sulphur); or as an emulsifier in solutions of DDT, chlordane, rhothane 2,4-D esters etc.; or for the preparation of DDT wettable powders. Flash point, $>$ 400°F; cloud point, (1% solution) 49/50°C.
CRILL K 1	8	Sorbitol mono-laurate. Nonionic. Clear, fawn to light brown coloured thick viscous liquid soluble in mineral oil, alcohol, xylol, toluene, acetone, cellosolve, carbon tetrachloride; dispersible in water, alkalis and acids and solutions of acids and electrolytes. Acidity less than 3%, sap value 170 mg, pH 6, sp.gr. at 15.5°C = 1.06. Use 7-10% in agricultural insecticides. Non hazardous and non irritant.
CRILL K 3	8	Sorbitol mono-stearate. Nonionic. Hard, fawn coloured waxy solid, insoluble in water; soluble in mineral oil, olive oil, carbon tetrachloride, ethylene glycol and xylol, slightly soluble in alcohol. Soap free edible wax and W/O emulsifier. Resistant to aqueous solutions of pH 0.5 to 12. Acidity less than 3%, sap value 142, sp.gr. 0.985 at 15.5°C. Use as auxiliary emulsifier in miticide and insecticide O/W emulsions and oil sprays.
CRILL K 16	8	Sorbitol mono-oleate. Nonionic technically pure grade. Viscous amber coloured material producing stable freeze resistant W/O emulsions and acting as an auxiliary O/W emulsifier and emollient. Oil soluble and soluble in hydrocarbons etc. but insoluble in water. Stable to mineral acids and dilute alkaline solutions and solutions of electrolytes. Acidity (oleic) less than 3%, sap value 150 mg, iodine value 31, sp.gr. 0.990 at 15.5°C, flash point 455, viscosity at 60°C 710 secs (Redwood No.1).

Product	Key	Indications of Manufacturer
CRILL S 6	8	Sorbitol mono-laurate polyoxyethylene derivative. Nonionic reddish brown liquid soluble in water, alkaline solutions and electrolyte solutions. Dispersible in hydrocarbons and vegetable oils. Soluble in alcohol; slightly foaming. Acidity 1% max, pH 6-7, sap value 57.7, iodine value 1.21. Use as wetting agent in aqueous systems.
CRILL S 8	8	Sorbitol mono-stearate polyoxyethylene derivative. Nonionic, light coloured pasty material, soluble in water, alcohol and aqueous solutions of acids, alkalis and electrolytes, toluol, cellosolve, carbon tetrachloride, ethyl acetate. Insoluble in olive oil, mineral oil and xylol. Acidity less than 3%, pH 7, iodine value 10. Use in oil emulsion sprays, benzylbenzoate dispersible concentrates, DDT dispersible powders.
CRILL S 10	8	Sorbitan mono-oleate polyoxyethylene derivative. Nonionic, light brown liquid, soluble in water, alcohol, toluol, acetone, cellosolve, methanol, and solutions of acids and electrolytes. Insoluble in mineral and vegetable oils and hydrocarbons. Acidity 1% max, sap value 47, iodine value 20. Emulsifier in insecticide concentrates; wetting agent for DDT powder.
DIGLYCOL LAURATE	24	Incorporated in a termite control composition, consisting of copper naphthenate (10 parts), orthochlorobenzol (20 parts), diglycol laurate (1 part).
DIGLYCOL STEARATE	24	Incorporated in a water repellent mildew proofer consisting of paraffin wax (1 part), fungicide (1 part), water (5 parts), diglycol stearate (1 part).

Product	Key	Indications of Manufacturer
DISPERSOL T	16	Essentially disodium salt of methylene dinaphthalene sulphonic acid. Anionic, pale buff coloured powder, slightly hygroscopic. Readily soluble in water forming neutral solutions, which are stable in hard water and in presence of high concentrations of acids, alkalis and many salts. Dispersing and deflocculating agent.
DML	7	Diethylene glycol mono-laurate; nonionic, yellow semi-solid material, dispersible in water and olive oil, soluble in xylol and white oils. Acidity 5% max; saponification value 172 mgm; iodine value 7; drop point 22°C. Use for emulsification of oils and solvents, and in agricultural sprays (e.g. pyrethrum.)
DUOMACS	3	Acetate salt of "Duomeens" (q.v.)
DUOMEENS	3	Fatty acid diamines, which form double salts with acetic acid. General formula is $RNH(CH_2)_3NH_2$ where R represents an alkyl group derived from coconut, tallow, soya or equivalent fatty acid.
EMPICOL 8971	20	Viscous pale yellow liquid with a characteristic faint fatty odour. The active matter components are derived from dodecyl benzene sulphonic acid and a high purity sulphated primary fatty alcohol. Designed primarily as a hard surface detergent. pH (1% aq. solution) approx: 7.0. Compatible with other nonionic and anionic surface agents. Foam boosted.
EMPICOL LZ POWDER	20	Sodium lauryl sulphate (approx. 88%). Balance made up of free fatty matter, sodium chloride, sodium sulphate and water. Light fine uniform free flowing powder white to light cream in colour; slightly alkaline. Use in wettable insecticide powder.

Product	Key	Indications of Manufacturer
EMPICOL SLE 1	20	Sodium ethoxylated lauryl sulphate (30% ± 1.5% active). Highly viscous, clear, very pale yellow aqueous solution with faint, characteristic odour. Sodium chloride < 1.5%. pH, (5% solution), 7.0 ± 0.5. An interesting property of this material lies in its ability to modify the viscosity as such, or in dilution, by addition of sodium chloride. It possesses a high stable foaming power.
EMPICOL SLE 2	20	Similar properties to EMPICOL SLE 1 but containing 25% ± 2% active matter (due to difference in mol.wt. of sulphated lauryl ether).
EMPILAN 1831	20	Liquid detergent super concentrate. Fairly viscous, amber coloured with characteristic faint fatty odour. (85% active content). Anionic/nonionic mixture. pH (1% solution) approx. 8.0.
EMPILAN POLYETHYLENE GLYCOL ESTERS	20	Anhydrous (99-100% active) nonionic compounds based on polyethylene glycols of mol.wt. 200, 400, 600, 800 or 1,500 combined with lauric, oleic and stearic acids. They exhibit, to varying degrees, emulsifying, wetting and detergent properties and range in physical aspect from deep straw liquid to dark cream paste/solid. Most versatile of these is Empilan AQ 100 (q.v.)
EMPILAN AQ 100 LIQUID	20	Polyethylene glycol 400 mono-oleate possessing emulsifying, wetting and detergent properties. It is 99% active anhydrous liquid, yellow in colour and of slight odour. A 2% aqueous solution is slightly acid. It is soluble in cold water, ethyl alcohol, vegetable oils and hot hydrocarbon solvents; it is partly soluble in cold mineral oils. Recommended for the preparation of DDT emulsions.

Product	Key	Indications of Manufacturer
EMULSIFIER 1990-A	3	Cationic emulsifier developed specially for the emulsification of pentachlorophenol. It is a dark liquid (75% active); sp.gr. 25°/25°C = 1.03; viscosity (25°C), 1480 cps; pour point, -8°C. Concentrations of 5% or less, (usually 1-3%), in the preferred PCP solvents (xylene or aromatic distillates) yield concentrates containing up to 15% PCP which store well and which form spontaneous emulsions, stable in hard and soft water.
EMULSIFIER S-1072	21	Amber coloured, viscous liquid particularly effective for the preparation of orthodichlorobenzene emulsions to control the bacterial growth and putrefaction odours in garbage dumps in large cities. A suitable spray is prepared by diluting 1 part of the concentrate consisting of ODCB (70-75%) and emulsifier (30-25%) with 50-100 parts water.
EMULSIFIER EFM	7	Tri-hydroxy methylamino methaneoctadecenoate. Nonionic emulsifier. Dark brown moderately viscous oil, slightly soluble in water and soap solutions. Good solubility in most of the common oils or fats. Possesses anti-oxidising properties and will neutralise rancidity in fats. Fatty oils and mineral oils can be easily emulsified with 1-5% and 1-3% wt EFM respectively.
EMULSIFIER NEGO	7	Polyoxyethylene oleate. Nonionic, brown liquid with faint pleasant smell. Soluble in water, alcohol and hydrocarbons. It gives increased wetting and emulsification in conjunction with wetting agents and found suitable for preparations of insecticide emulsion concentrates based on DDT, BHC etc.
ESTAX 5	31	Glyceryl monostearate (powder or lump). Use in grafting adhesive: Estax 5 (12%), Castor oil (3%), Rosin (62.5%), Yellow Beeswax (12.5%), Charcoal (10%).

Product	Key	Indications of Manufacturer
ESTAX 37	31	Polyglycol 400 mono-oleate liquid. Use 4-6% w in conjunction with 2% lauric diethanolamide to prepare emulsion concentrates containing DDT, BHC in xylene. Use neutral grade for 2,4-D ester emulsion concentrates.
ESTAX 53	31	Polyglycol 400 mono-laurate viscous liquid. Use 5% in conjunction with 2% oleic diethanolamide to formulate dieldrin emulsion concentrate based on xylene.
'ETHODUOMEENS'	3	Reaction products of an ethylene oxide and an N-alkyl trimethylene diamine. The presence of two amine groups in the molecul increases the cationic properties.
ETHOFATS	3	Mono-fatty or rosin acid esters of polyoxyethylene glycols. Nonionic esters which are normally fairly stable in mildly acid or alkaline solutions. For example.
ETHOFAT 142/20	3	Red oil type fatty acid containing 10 moles of ethylene oxide. sp.gr. 1.028. Soluble in isopropanol, carbon tetrachloride, dioxane and benzene. Use in preparation of chlordane emul.conc. (nonionic), DDT/oil larvicide, and self emulsifying agricultura spray oil; or, in conjunction with Arquad 2 C, to prepare cationic emul.concs. based on DDT. chlordane and toxaphene.
'ETHOMEENS'	3	Tertiary amines possessing one fatty alkyl group (derived from various fatty sources having from 12 to 18 carbon atoms) and two polyoxyethylene groups attached to the nitrogen. These compounds are cationic in nature although by increasing the ethylene oxide content they will behave more like nonionics.

Product	Key	Indications of Manufacturer
ETHOMIDS	3	N,N-substituted fatty acid amides, with polyoxyethylene groups as substituents. Nonionic compounds which normally are stable in acid or alkaline solution.
ETHYLAN BCP	18	Nonionic polyglycol ether. For general emulsification in aromatic solvents. Can be used in conjunction with Ethylan ENT (q.v.)
ETHYLAN BSE	18	Blended nonionic emulsifier. Of use with certain aromatic solvents for general emulsification; also for pyrethrum extract in Shell Oudina and Risella Oil in conjunction with Ethylan LD (q.v.); for emulsification of DNOC and other nitro-bodies in aromatic solvent. The solution may be cloudy and should be cleared by the addition of 1% Ethylan OE (q.v.) Iranolin solvent KEB is readily emulsified by Ethylan BSE (3%-5%).
ETHYLAN BV	18	Anhydrous, nonionic emulsifying agent which must be used in conjunction with Arylan CA (q.v.) if the best results are to be obtained. It is a soft white paste below 18°C, which melts to a clear pale amber liquid. The flash point is over 150°F (65°C).
ETHYLAN ENT	18	Neutral. Nonionic polyglycol ether based on an alkyl phenol (90% active). Yellow viscous liquid of slight odour, gelling at -10°C. Oil soluble emulsifying agent for mineral oils and fortified mineral oils, certain of which may require the use of a coupling agent such as oleine, cetyl, oleyl alcohol, Ethylan SD etc. to obtain improved stability. Ethylan ENT is essentially a hydrophobic surface active agent. Use in conjunction with Ethylan BCP, SW, etc. if greater hydrophilic character required.
ETHYLAN ENT EXTRA	18	100% active form of Ethylan ENT (q.v.)

Product	Key	Indications of Manufacturer
ETHYLAN LD	18	High active coconut diethanolamide. Use in conjunction with Agrilan A (q.v.) to provide a combination of more hydrophobic nature.
ETHYLAN OE	18	Nonionic condensation product of fatty alcohol and ethylene oxide.
ETHYLAN TU	18	Alkyl aryl polyglycol ether based on alkyl phenol (100% active). Neutral, pale straw coloured, viscous liquid of faint odour, clouding at 41°F - 50°F and gelling at 32°F and stable to acids, alkalis and metallic salts. Soluble in alcohols, benzene, ether and water in all proportions. Suggested as emulsifying agent for aromatic hydrocarbons and mineral oils and in conjunction with Agrilan A to provide a combination of a more hydrophilic nature.
FIXANOL C	16	Technical grade of cetyl pyridinium bromide. Anhydrous cationic, brown coloured low melting soft solid. Soluble in cold and hot water (slightly acidic reaction) in many organic solvents and in certain oils and waxes. Clear stable solutions can be obtained in the presence of acids and salts such as sodium sulphate, calcium chloride, etc. Use as wetter, emulsifier and dispersing agent.
FIXANOL VR	16	Technical grade of tetradecyl pyridinium bromide. Anhydrous cationic brown coloured soft solid of low melting point. Properties similar to Fixanol C (q.v.) but with higher maximum solubility and greater wetting out in aqueous solutions.
GA WETTING AGENTS	14	Polyoxyethylene derivatives for use as agricultural wetting agents.
GA 1250	14	Polyoxyethylene sorbitan mono-oleate combined with substances containing free carboxylic groups. For preparation of lindane wettable powder.

Product	Key	Indications of Manufacturer
GA 4250	14	Polyoxyethylene ester of a mixture of fatty acids and resinic acids combined with substances which contain free carboxylic groups. For preparation of lindane wettable powder.
GA 5260 GA 5590	14	Polyoxyethylene stearate combined with substances containing free carboxylic groups. For preparation of dieldrin, BHC, lindane, DDT wettable powders.
GA 6260 GA 6590	14	Polyoxyethylene ethers of fatty alcohols combined with substances containing free carboxylic groups. For preparation of dieldrin, BHC, DDT, lindane wettable powders.
GEMEX 29	9	Aliphatic nitrogen compound. Cationic emulsifier, soluble in water. For preparation of emulsion concentrates.
GP 2113	8	An ethylene oxide derivative, and an alkyl aryl polyether alcohol. Clear light coloured viscous oily material containing only traces of moisture etc. and is practically 100% active. Specially formulated as a nonionic O/W emulsifier for aldrin and dieldrin concentrates. Soluble in water, trichlorethylene, xylol etc.; insoluble in kerosene, mineral oil and white spirit. For emulsification of solvents, oils and insecticides.
IALINE SPREADER	5	Rosin/caseinate product used as a sticker with colloidal copper, colloidal sulphur, etc. The product, in the form of a water dispersible powder, is pre-mixed by creaming with a small quantity of water. It is generally applied at the rate of 2 lb. per 100 gal. spray.
L53	7	Polyoxyethylene fatty acid ester. Light brownish oil in warm weather becoming pasty in cold. Faint pleasant aroma. Water soluble. Forms stable solutions. Nonionic

Product	Key	Indications of Manufacturer
L53 (Contd.)	7	wetter, very effective at low concentrations. Hydrolysed by strong alkalis, not affected by mild acids. Compatible with many oils. and organic liquids. Dissolves many organic insecticides such as DDT, HETP, chlordane, etc. and being substantially anhydrous does not affect their stability.
LANKROPOL WAD	18	Amine salt of a monoester sulphate. Use as wetting agent and spreader, particularly for amine salts of phenoxyacetic acids.
LANKROPOL WNA	18	Sodium salt of a monoester sulphate. Use as wetting agent and spreader particularly for inorganic salts of phenoxyacetic acids.
LENSEX	26	Paste form of Teepol (q.v.) 44% active.
LENSODEL A	26	Neutral wetting agent containing 35% sodium dinonyl phosphate in aqueous alcohol solution. Colourless viscous liquid sp.gr. 1.001 at 60/60°F, flash point 55°F, pH 6-7 (0.1% wt aqueous solution), stable down to 30°C. Compatible with anionics and water soluble nonionics. It is very efficient in dilute solutions of strong alkalis but the wetting power is reduced in dilute acid solutions and in concentrations of other electrolytes above 2% wt.
LISSAPOL C PASTE	16	Aqueous paste containing 28-32% wt of the sodium salt of a sulphated cetyl/oleyl alcohol mixture. Anionic, cream coloured smooth paste soluble in cold or more readily hot water to form neutral or very slightly alkaline solutions, which are stable to hard water, acids, alkalis and many inorganic salts. Possesses wetting, dispersing and emulsifying properties.
LISSAPOL C POWDER	16	Anhydrous form of Lissapol C Paste, containing the same type and amount of active agent. Fine cream coloured powder.

Product	Key	Indications of Manufacturer
LISSAPOL LS PASTE	16	Aqueous paste containing 20% sodium oleyl p-anisidide sulphonate. Anionic. Light fawn coloured paste. Soluble in cold or, more readily, hot water forming neutral solutions of outstanding stability to acids, alkalis, inorganic salts and hard water.
LISSAPOL N	16	Aqueous solution of an alkylated phenol ethylene oxide condensate. Nonionic amber coloured free flowing liquid above 10-12°C. Negative solubility temperature coefficient. Good stability to acid, alkali or salt media. Detergent, wetting agent and emulsifier.
LISSAPOL NX	16	Anhydrous form of Lissapol N (q.v.), the active ingredient being about four times more concentrated. Properties similar to Lissapol N. Brown coloured viscous liquid, pourable above 10°C. Soluble up to at least 10% in a variety of solvents; practically insoluble in mineral oils and white spirit. May be incorporated into powder products as wetting, dispersing or de-dusting agent.
LISSAPOL NXA	16	Similar to Lissapol NX (q.v.) but possessing a controlled low water content. Of special value for compounding water sensitive insecticides of the organophosphate type.
LISSOLAMINE A 50% PASTE	16	Aqueous paste containing approx. 50% technical cetyltrimethyl ammonium bromide. Cationic, cream coloured paste with slight odour of trimethylamine. Use as wetter, spreader, emulsifier and dispersing agent particularly under acidic conditions.
LUBROL E	16	Alkyl phenol condensed with ethylene oxide. Controlled low water content; essentially 100% active agent. Nonionic, pale amber to straw coloured viscous liquid becoming semi-solid below 0°C. Gives neutral to slightly alkaline reaction. Miscible in all proportions with aromatic hydrocarbon

Product	Key	Indications of Manufacturer
LUBROL E (Contd.)	16	solvents but insoluble or only slightly soluble in paraffinic solvents and mineral oils. Forms clear solutions in cold water becoming cloudy on warming. It does not ionise or form salts and possesses good chemical stability to acids alkalis and salts dissolved in water. It is similar in performance to Lissapol NX (q.v.) but having superior physical properties and appearance.
LUBROL G	16	Blended surfactant based on a nonionic ethylene oxide condensate. Brown coloured, neutral, viscous liquid giving stable emulsions in soft and hard water. Anhydrous emulsifier specially designed for use with paraffinic solvents.
LUBROL MOA	16	Similar composition to Lubrol W (q.v.) but with a shorter polyethylene glycol chain conferring better solubility in organic solvents and oils. Anhydrous, nonionic, neutral, brown viscous liquid which separates out at low temperatures (reversible). It forms emulsions which are stable to a variety of conditions and is recommended for emulsifying oils and waxes preferably in conjunction with Lissapol NX or Lubrol W.
LUBROL W	16	Anhydrous condensation product of a long chain fatty alcohol and ethylene oxide. Nonionic, light coloured, low melting soft solid forming neutral solutions, which do not ionise or form salts. It is recommended for emulsifying waxes and for preparing miscible oil type products.
MANOXOL N (100%)	12	Sodium di-nonyl sulphosuccinate. Pure, colourless and practically odourless, wax-like, slightly hygroscopic substance, stable up to 150°C. Not suitable for use in strongly alkaline solutions. It is more effective than Manoxol OT in depressing surface tension at ordinary working

Product	Key	Indications of Manufacturer
MANOXOL N (100%) (Contd.)	12	concentrates, and is of value in reducing interfacial tension between mineral oil and water, and in promoting the wetting and spread of spray liquid on leaf or insect surface. Anhydrous wetting agent soluble in many organic liquids. It is best dissolved in water by steeping for 24 hours.
MANOXOL N 60% SOLUTION	12	Clear liquid containing 60% by wt. sodium di-nonyl sulphosuccinate in a mixture of water and alcohol. It is conveniently diluted by pouring into ten times its weight of water. A mobile but not entirely clear dispersion results which dissolves completely on addition to water in volume.
MANOXOL OT (100%)	12	Sodium di-octyl sulphosuccinate. Pure, wax-like material supplied in pellet form. Somewhat plastic and slightly hygroscopic. Soluble in most organic solvents of both polar and non-polar character at room and at elevated temperature; also soluble in oils, fats, waxes, resins and similar organic materials when heated to approximately 75°C. and higher. Its solubility in water is about 1.5 g/100 ml rising to 5.5 g at 70°C. Since the pellets dissolve very slowly in water it is usual to "soak" them overnight, but they may be dissolved more readily by stirring and the addition of a miscible organic solvent (e.g. alcohol or acetone.) It is not suitable for use in strongly alkaline solutions (pH >10). Usable with wettable sulphur, mineral oil emulsions for spraying orchards, oil sprays, as emulsifying agent with DDT for incorporation in insecticides and larvicides, with weed-killers, and for use with plant hormones for prevention of apple-drop before harvest.

Product	Key	Indications of Manufacturer
MANOXOL OT 60%	12	This is the most concentrated grade of Manoxol OT at present available in the liquid form. It is a clear mobile product containing 60% Manoxol OT and 40% of a mixture of water and alcohol.
MANOXOL OT 20%	12	This is a clear mobile solution. It contains 20% Manoxol OT, alcohol and water making up the remaining 80%. This product dissolves readily in water at room temperature or higher and no special technique for its dilution is required. Also known as Manoxol OT/A.
MANOXOL OT 60% AQUEOUS GEL	12	This is a clear, moderately viscous gel containing 60% Manoxol OT and 40% water. This product requires a soaking treatment for making dilutions in much the same way as does Manoxol OT Pure 100%, but it dissolves and disperses more readily than the latter product. It is recommended for purposes where complete freedom from organic solvents is desired.
MANOXOL OT/A	12	See MANOXOL OT 20%.
MB 320	25	Anhydrous cyclohexylamine lauryl sulphate. Anionic, cream brown waxy solid readily soluble in cold water and in many organic solvents such as benzol, xylol, kerosene etc. It is in general use as an emulsifying agent for insecticide concentrates containing DDT, BHC, 2,4-D etc. and is effective in low concentrations. Appears to function synergistically when mixed with nonionics of the polyoxyethylene ether type. It is of special interest as an anionic oil soluble surfactant.
MERGITAL OP	27	Nonionic, alkyl phenol ethylene oxide condensate, 100% concentrate. Light amber coloured liquid, readily soluble in cold and hot water. Completely stable to acids alkalis and unaffected by hard water or

Product	Key	Indications of Manufacturer
MERGITAL OP (Contd.)	27	the presence of metallic ions. Compatible with anionic or cationic type surfactants. Use in preparing emulsion concentrates, to yield O/W emulsions on dilution with water. Its wetting action enhances retention of the pesticidal constituent on foliage.
METANOL SDB PASTE	17	Alkyl aryl sodium sulphonate (40% active) possessing emulsifying, wetting and suspending properties; stable to hard water, acids and alkalies. May be added to powder products to improve spreadability and penetration. Will facilitate passage of wettable powder sprays through nozzle orifices.
METAPOL HC Conc.	17	Polyoxyethylene glycol phenol ether, practically anhydrous, is for use as an auxiliary emulsifying agent with Mulsol A (q.v.) for the production of insecticide emulsions. The diluted material, available as Metapol HC, is for use as a wetting, spreading and dispersing agent.
METAPOL NK	17	Polyoxyethylene glycol ethyl ether. Wetting, spreading and dispersing agent.
MULSOLS A, LEC, OE	17	Emulsifying agents of similar constitution to Metapol NK, to prepare emulsions of mineral oils for insecticidal spraying.
NANSA BX	20	Anionic wetting out agent. Non-hygroscopic free flowing, white to fawn coloured powder in bead form with faint odour, consisting of: Sodium alkyl naphthalene sulphonate 40% min Moisture 5% max Sodium Sulphate Balance pH (1% solution) = 7.5-8.5. The wetting power of solutions is not affected by dilute acids, alkalis, divalent salts or hard water. For use in preparing insecticidal wettable powders and, at a concentration of 1%, as a spreader in agricultural sprays.

Product	Key	Indications of Manufacturer
NANSA HS	20	A high active dodecyl benzene sodium sulphonate derived from tetra propylene polymer benzene hydrocarbon. Light fawn to deep cream powder consisting of: Dodecyl benzene sodium sulphonate 78% ± 2% Water 5% max Sodium chloride 0.5% max Sodium sulphate 15% ± 3% pH (0.4% solution) = 9-10. The powder is hygroscopic. Available in flake form as Nansa HS flake. (Crisp flake, cream in colour, with faint characteristic odour. pH (0.4% solution) 7-8.5. Possesses good wetting properties and is stable to acids alkalis, divalent salts and hard water.
NANSA S	20	Dodecyl benzene sodium sulphonate (40% active). A spray dried, non-hygroscopic, free flowing powder consisting of: Active matter 40% (approx.) Sodium phosphate 2% Moisture 2% Sodium chloride Trace Sodium sulphate Balance It is a light powder in bead form, white to pale cream coloured, of very faint characteristic odour. An 0.4% solution is slightly alkaline in reaction. It possesses wetting and foaming properties. It is stable to acids, alkalis and hard water. It may be used in sea water. Recommended as the wetting out compound in the formulation of DDT and BHC wettable powders.
NERVAN CFB	22	Sodium alkyl naphthalene sulphonate, 40% active. Anionic wetting agent for insecticide wettable powders.
NITRILE 12	11	Fatty acid nitrile. Described as insect repellent.
NITRILE KK	11	Fatty acid nitrile. Described as rodent repellent.

Product	Key	Indications of Manufacturer
NONEX SURFACTANTS	9	Wetting and emulsifying agents of polyethylene glycol type.
NONEX 25	9	Nonionic polyethylene glycol 200 monoleate. Brown fluid, slightly soluble in water, soluble in mineral oil and saponifiable (groundnut) oil; approx. m.p. - 5°C. For use in emulsion concentrates (e.g. DDT) based on hydrocarbon oils or petroleum spirit extracts.
NONEX 26	9	Nonionic polyethylene glycol 300 monoleate. Brown liquid dispersible in water at 20°C, partly soluble in mineral oil, soluble in saponifiable (groundnut) oil; approx. m.p, - 5°C. For use in emulsion concentrates (e.g. pentachlorophenol) based on petroleum spirit extracts.
NONEX 30	9	Nonionic, polyethylene glycol 400 monoleate. Light brown fluid dispersible in water at 20°C, partly soluble in mineral oil, soluble in saponifiable (groundnut) oil; melts at 0°C. For use in emulsifiable concentrates containing chlorophenoxyacetic esters (2,4-D or 2,4,5-T) based on high flash petroleum spirit. Certain experimental modifications of Nonex 30 are available which promote rapid dispersion of these miscible oils in large volumes of water.
NONEX 52	9	Nonionic, polyethylene glycol 600 monoleate. Light brown paste melting at 17°C (approx.), soluble in water, insoluble in mineral oil and partly soluble in saponifiable (groundnut) oil. Suitable for the preparation of emulsifiable concentrates (e.g. DDT) based on xylol and similar aromatic spirits.

Product	Key	Indications of Manufacturer
NONEX 102	9	Nonionic polyethylene glycol 300 dilaurate. Amber fluid, dispersible in water at 20°C, soluble in mineral and saponifiable (groundnut) oils; approx. m.p. 7°C. For use in emulsifiable concentrates (e.g. pyrethrum) based on high grade mineral oils or petroleum fractions.
NONEX 139	9	Nonionic, polyethylene 400 monolaurate (refined): light yellow fluid or paste; soluble in water, partly soluble in mineral and saponifiable oils. m.p. 12°C (approx.). Mild and non-injurious wetting agent for plant sprays. (More vigorous wetters foam excessively and run off foliage).
NONEX 501	9	Nonionic, methoxy-polyethylene glycol laurate (refined). Amber fluid, soluble in water at 20°C, insoluble in mineral oil and partly soluble in saponifiable oil. Mild and non-injurious wetting agent for plant sprays.
NONIDET P 40 (TP 7136)	26	Polyethylene oxide condensate (100%). Neutral, nonionic, pale straw coloured, slightly viscous liquid of sp.gr. 1.060 at 60/60°F. Stable and clear between 0°C and 70°C. Compatible with all types of surfactants. Unaffected by acids or alkalis. Use as wetting agent.
NONIDET P 42 (TP 7143)	26	Polyethylene oxide condensate (approx. 27%) Neutral, nonionic, pale straw coloured, slightly viscous liquid of sp.gr. 1.027-1.029 at 60/60°F. Stable between 0°and 60°C. Turbidity likely at higher temperatures. Compatible with all types of surfactants. Unaffected by acids or alkalis. Use as wetting agent.
PEG ESTERS	22	eg. Polyethylene glycol esters; nonionic emulsifiers for general use.

Product	Key	Indications of Manufacturer
PENTRONE T	10	Fatty alcohol sulphate. Light coloured powder with faint pleasant smell suitable as a general wetting agent. It dissolves readily in warm water and is stable to hard water, dilute acids and alkalis. Also available as paste and powder concentrate.
PERMINAL BX	16	Sodium salt of alkylated naphthalene sulphonic acid with a proportion of sodium sulphate and sodium naphthalene-beta-sulphonate. Anionic, fawn coloured powder, slightly hygroscopic. It dissolves readily in water and is stable in the presence of acids, alkalis and many other electrolytes. It is primarily a wetting and dispersing agent.
PERMINAL COL	16	Combination of a fatty alcohol ethylene oxide type surfactant with an anionic agent of the highly sulphated oil type, with corresponding improvement in solubility and stability. Clear golden yellow liquid with a tendency to separate at low temperatures (reversible). Dissolves very readily in hot and cold water yielding neutral solutions. Soluble and stable in hard water and in the presence of quite high concentrations of mineral and organic acids, alkalis and salts. Wetting and dispersing agent.
PERMINAL EML	16	Aqueous solution of a sodium alkylnaphthalene sulphonate together with a specially liquified colloid and other emulsion stabilising agents. Anionic, brown viscous liquid, pourable above 5^oC, readily forming neutral aqueous solutions which are stable to the addition of alkalis, organic and mineral acids and many metallic salts, and to hard water. Of particular value in the manufacture of emulsions for horticultural sprays and two phase (mayonnaise) type O/W emulsions.

Product	Key	Indications of Manufacturer
PERMINAL PW	16	Anhydrous form of Perminal EML. Buff coloured granular powder, slightly hygroscopic.
PETROMORS	19	Blends of mineral oil and oil soluble sulphonates. Anionic emulsifiers miscible in all proportions with oil and many organic solvents for preparing fine, stable emulsions.
PETROSOLS	19	Anionic water soluble petroleum sulphonates of low solubility in oils for use as wetters and spreaders. For example:
PETROSOL 33	19	Dark liquid containing 33% active petroleum alkyl aryl sulphonates miscible with water in all proportions. Used as a wetting agent in agricultural sprays.
POLAMINE	8	A powerful anionic emulsifier employing property characteristics of wool wax alcohols. Acidity as oleic Acid 0.02-0.15% Saponification value 1.0 - 2.0 Iodine value 6 - 8.5 It is a cream coloured material of slightly granular appearance with slight odour. It is soluble in cellosolve, carbon tetrachloride and ethylene glycol; insoluble in alcohols and acetone, and partly soluble in mineral oils. It is intended for the preparation of liquid O/W emulsions of mineral oils, vegetable oils and solvents.
POLYETHYLENE GLYCOL ESTERS	1	General purpose emulsifiers.
POLYETHYLENE GLYCOL 400 MONO-OLEATE	24	Nonionic emulsifier for preparation of insecticide emulsions, e.g. DDT.
POLYETHYLENE GLYCOL 600 MONO-LAURATE	24	Nonionic wetting and penetrating agent. Tenfold increase in effect reported when used in conjunction with nicotine spray.

Product	Key	Indications of Manufacturer
POLYRADS	13	Products obtained by reacting technical dehydroabietylamine (Rosin Amine D) with ethylene oxide.
POLYRAD 1100	13	Containing 11 moles ethylene oxide per mole Rosin Amine D. Use as cationic emulsifier for preparation of acid stable emulsions and emulsifiable concentrates e.g. 2,4-D. Concentrates can subsequently be diluted with either water or petroleum hydrocarbons.
POLYRAD 1110	13	Similar in composition and use to Polyrad 1100 but containing 10% by wt free Rosin Amine D.
POLYRAD 4500	13	Containing 45 moles ethylene oxide per mole Rosin Amine D. Reccmmended as a dispersing agent for incorporation of insoluble solids into aqueous systems. Good dispersion can be prepared using 4 to 6 parts Polyrad 4500 per 100 parts dry powder. It is suitable for cationic and nonionic systems.
PROPYLENE GLYCOL MONO STEARATE	24	Incorporated at 2% in insect repellent gel (U.S.P. 2,404,698)
QUERTON HPLES	11	Stearine dimethyl ethyl ammonium ethyl sulphate (100%). Cationic emulsifier, water and oil soluble. Querton HPLES is recommended for fruit washing and as a fungicide.
QUERTON 2 KKES	11	Mixed alkyl methyl ethyl ammonium ethyl sulphate (100%). Specially indicated for the preparation of DDT emulsions.
QUERTON OLES	11	Olein dimethyl ethyl ammonium ethyl sulphate (25 or 100% grades). Emulsifier; fungicide.

Product	Key	Indications of Manufacturer
RD 1869	3	Agricultural toxicant emulsifier developed to meet the requirements for herbicide and other pesticide formulations. It is a blended material to give maximum emulsifying properties and stable emulsions in hard and soft water. Soluble in aromatic, chlorinated and polar solvents. Recommended particularly for use with chlordane, toxaphene and esters of 2,4-D and 2,4,5-T, in solvent or non-solvent systems.
RD 1905	3	Emulsifier, recommended for use with DDT and lindane in amounts of 1-5% calculated on an emulsion containing 25% active material and 70-74% solvent (xylol).
RD 1917	3	Emulsifier recommended for use with herbicide concentrates containing solvents. For example, 1-2% may be used in formulations containing 4 lb. acid 2,4-D per gal. concentrate. These concentrates may be diluted with kerosene to form clear solutions.
RD 1918	3	Emulsifier recommended for use with herbicide concentrates containing solvents similar to RD 1917 (q.v.).
SHELLESTOL	26	A solution of the sodium salts of secondary alkyl sulphates (21% active) marketed in convenient quantities for limited scale agricultural and horticultural spraying.
SINTRA WAX SE	2	Brownish yellow wax (lumps), setting point 65-67°C, sp.gr. (at 15°C) 0.98, forming stable aqueous colloidal solutions of wax with very good freeze/thaw properties. Emulsifies readily. Preparations containing up to 25% total wax solids are completely mobile. They form translucent aqueous colloidal solutions, since the particle size is extremely small, much smaller than of ordinary emulsions.

Product	Key	Indications of Manufacturer
SORBESTER EMULSIFIERS	15	These are of three types. Type P. Mixed esters of the sorbitans obtained by partial esterification of sorbitol with long chain fatty acids. Predominantly hydrophobic therefore oil soluble. Promote W/O emulsions. Type Q. Produced by condensing ethylene oxide with the P type esters. Predominantly hydrophilic therefore water soluble. Promote O/W emulsions. Type PQ. Mixture of P and Q types. Frequently more effective than the single emulsifiers.
For example: SORBESTER EMULSIFIER P 12	15	Sorbitan monolaurate. Almost colourless waxy semi solid, soluble in alcohol and most organic solvents. Easily dispersible in aqueous media. Melting point 25-30°C Acid value 8 Saponification value 175 Hydroxyl value 340 Use as spreading agent in agricultural sprays and as auxiliary O/W emulsifier for kerosene.
SORBESTER EMULSIFIER Q 12	15	Polyoxyethylene sorbitan monolaurate. Pale yellow liquid, soluble in water, alcohol and many organic liquids. Viscosity at 25°C 500 c/p SG at 15.5°C 1.08 Acid value Nil Saponification value 70 Hydroxyl value 135 For use as O/W emulsifier for kerosene, as 'solubiliser' for dispersing oils in water, and as auxiliary W/O emulsifier for decreasing particle size without excessive milling.

Product	Key	Indications of Manufacturer
SOVIX	30	Nonionic wetting agent of ethylene oxide condensate type. Anhydrous, rather viscous at low temperatures, applicable at the rate of 2 or 4 fl.oz. per 100 gal. of water, as a wetting agent in agricultural sprays. It has also been satisfactorily used for washing out spraying machines, (4 fl.oz. per 100 gal. of water.)
SYNTHETICS AD160	13	Polyethylene glycol ether of a rosin alcohol. Water soluble, nonionic, amber coloured wax. pH (1% soln.) 8-10.
SYNTHETICS AD400	13	Polyethylene glycol ether of a rosin alcohol. Water soluble, nonionic, white wax. pH (1% soln.) 8-10.
SYNTHETICS AF40	13	Polyethylene glycol ether of an alkylated phenol. Nonionic amber coloured liquid, very slightly soluble in water, soluble in alcohol and kerosene. pH (1% soln.) 6-8; sp.gr. 1.027.
SYNTHETICS AF100	13	Polyethylene glycol ether of an alkylated phenol. Water soluble nonionic, amber coloured liquid. pH (1% soln.) 6-8; sp.gr. 1.056.
SYNTHETICS AR100	13	Polyethylene glycol ester of rosin. Nonionic straw coloured liquid very slightly soluble in water, soluble in benzene, insoluble in kerosene. pH (1% soln.) 8-10; sp.gr. 1.094.
SYNTHETICS AR150	13	Polyethylene glycol ester of rosin. Water soluble nonionic straw liquid/wax. pH (1% soln.) 8-10; sp.gr. 1.099.
SYNTHETICS AR201	13	Polyethylene glycol ester of rosin. Water soluble nonionic straw coloured liquid. pH (1% soln.) 7-9; sp.gr. 1.102.
TEEPOL 410	26	See SHELLESTOL.

Product	Key	Indications of Manufacturer
TEEPOL 514	26	Liquid product containing 27% active mixture of secondary alkyl sulphates and alkyl aryl sulphonates.
TEEPOL 530	26	Liquid product (approx. 27% active) consisting principally of secondary alkyl sulphates with a small amount of potassium neutralised material (to increase the physical stability). Used mainly with contact insecticides (e.g. nicotine, HETP, TEPP and sodium fluoro-acetate) at ½ pint per 100 gal. diluted wash, to ensure proper wetting of the pests to be controlled and to improve penetration of the spray material. It can also be added to residual sprays (e.g. derris, lead arsenate, copper compounds, sulphur and chlorinated hydrocarbons) at 4 fl.oz. per 100 gal. diluted wash to assist the spread, adhesion and deposition of the toxicant on leaf or plant surfaces.
TEEPOL POWDER 'A'	26	Spray dried material at present based on secondary alkyl sulphates. It will shortly consist of a mixture of these and alkyl aryl sulphonates. It also contains tetra sodium pyrophosphate (10%), a small amount of moisture and sodium sulphate (balance).
TEEPOL L	26	Based upon higher alkyl sulphates. Pale amber coloured liquid soluble in hot or cold water of any degree of hardness to give clear solutions. Stable over wide pH range and in the presence of electrolytes.
TERGITOLS	29	Wetting and emulsifying agents.
TERGITOL 7	29	Aqueous solution of sodium hepta decyl sulphate (25%). Anionic wetting agent.

Product	Key	Indications of Manufacturer
TERGITOL NP-14	29	Nonionic alkyl phenyl polyethylene glycol ether, 100% active. Virtually colourless liquid; pH (0.1% aq. soln.) 6.2; sp.gr. (20/20°C) 1.031; apparent viscosity (centistokes) 365.4 and 8.8 at 20°C and 100°C respectively; flash point (open cup) 480°F. Solubility in water <0.01. Highly oil soluble being completely soluble in kerosene and aliphatic hydrocarbons in which it forms W/O emulsions. Coupling agent for use in conjunction with NPX or NP-27 (qqv.) to form O/W emulsions of aliphatic hydrocarbons.
TERGITOL NP-27	29	Nonionic, alkyl phenyl polyethylene glycol ether 100% active. Virtually colourless liquid. pH (0.1% aq.soln.), 6.1; sp.gr. (20/20°C), 1.055; apparent viscosities (centistokes) 224 and 8.7 at 20°C and 100°C respectively; flash point (open cup), 525°F. It is soluble in aromatic solvents, but slightly less water soluble (20% by wt. at 20°C) than Tergitol NPX (q.v.) Its cloud point in 0.5% aqueous solutions is 8°C. Use as an emulsifier for pesticide concentrates, or as wetter and dispersant in the preparation of wettable powders at a concentration of 0.2 to 2.0% w/w on finished powder.
TERGITOL NPX (anhydrous)	29	Anhydrous nonionic, alkyl phenyl polyethylene glycol ether, 100% active. Virtually colourless liquid; pH (0.1% aq.soln.), 7.5; sp.gr. (20/20°C), 1.063; apparent viscosities (centistokes) 373.8 and 11.9 at 20°C and 100°C respectively; flash point (open cup), 550°F. It is completely miscible with water at temperatures below 60°C although cold water solutions gel when the concentration of NPX is between 40 and 60 per cent. It is stable in the presence of acids, bases and salts and does not decompose at temperatures up to 300°F. Compatible with soaps and

Product	Key	Indications of Manufacturer
TERGITOL NPX (anhydrous) (Contd.)	29	other types of surfactants. Soluble in a wide variety of alcohols, ketones, glycols, glycol-ethers and esters. Miscible with chlorinated and aromatic solvents but not with aliphatic hydrocarbons such as kerosene. It can usually be coupled into solution with aliphatic solvents or mineral, animal and vegetable oils by the use of coupling agents such as butyl cellosolve or by NP.14 or Amine 220, (q.v.). It is suitable for the formulation of wettable powders to which it imparts wetting and dispersion properties and may be incorporated at 0.2 to 2.0% w/w on the finished powder. Alone, or sometimes in conjunction with other surfactants such as Tergitol XD or Amine 220 (qqv.), it is a useful emulsifier.
TERGITOL P 28	29	Aqueous solution of sodium dioctyl phosphate (25%). General purpose anionic wetting agent, insoluble in acid, stable in alkali.
TERGITOL TD TERGITOL TMN	29	Polyethylene glycol alkyl ethers (100% active). General purpose nonionic emulsifiers.
TERGITOL XD	29	Nonionic, polyalkylene glycol ether, 100% active. This is an odourless, soft, white solid at room temperature. pH (0.1% aq.soln.) 6.0; sp.gr. (40/20°C) 1.053. Apparent viscosities (centistokes) 177 and 54.4 at 55°C and 98.88°C respectively; flash point (open cup) 480°F. It is stable in the presence of acids, bases and salts and is compatible with anionic, cationic and other nonionic agents. It is completely soluble in water. Dilute aqueous solutions are clear and bright. Concentrated solutions, 20% and above, form clear gels. It is readily soluble in aromatic and chlorinated solvents. Its solubility in mineral, animal and vegetable oils is influenced by the degree of refinement of the oils.

Product	Key	Indications of Manufacturer
TERGITOL XD (Contd.)	29	It can be made soluble in most refined oils by the use of small amounts of conventional coupling agents (isopropanol or hexylene glycol.) It is a powerful emulsifier with low foaming characteristics.
TEXOFORS	10	Polyoxyethylene/fatty group combinations. General purpose emulsifiers. Products vary in appearance from pale straw/cream waxy solids (AL, B1, E13) to pale amber/brown liquids (CD, D1, F). The properties are conditioned by variation in the length of the oxyethylene chain and by the chemical nature of the hydrophobic group. Texofor A1 is used for emulsification of copper, lead and zinc naphthenates, usually in a medium consisting of approximately 70% oil and 30% water. Texofor DC, 65A3 and F4 have been found particularly useful for mineral oil emulsification, either alone or in conjunction with Texofor F. Texofor D40, in equal proportion with Texofor F, is suitable for the emulsification of ether-type insecticides; in such case, the addition of a small proportion of oleyl alcohol has been found to increase the stability of the emulsion. Emulsions of DDT in xylene and solvent naphtha can be readily obtained using 3% of Texofor F on the total emulsion. Texofor F, in conjunction with Collone AC, is being used with weed killers such as 2,4-D, having paraffin as a diluent. To obtain an emulsion of 2,4-D ester with water, 10% Texofor F15 on the total emulsion is suggested. Texofors may be used for the emulsification of aldrin and dieldrin in various solvents. Where kerosene is the solvent 5% Texofor CD on total weight of the solution is recommended. With xylene as solvent 5% Texofors F or D20, or Collone AC may be employed.

Product	Key	Indications of Manufacturer
TEXOFORS (Contd.)	10	Gamma benzene hexachloride in aromatic solvents can be emulsified by Texofor F and Collone AC. Insecticidal powders may be rendered dispersible by spraying the powder with Texofor D1, either alone or preferably in a volatile solvent, during milling. To increase the wetting and spreading power of liquid spray products, Texofor F is most suitable, very small quantities being required to give effective wetting.
TRITON B 1956	6	Modified phthalic glycerol alkyd resin. Clear amber, nonionic, free flowing liquid of sp.gr. 1.055 at 25°C. Soluble in water, vegetable oils and petroleum spray oils. pH (5% solids) 7.2, viscosity (Saybolt) 245 secs. at 100°F. Use as spreader, depositing agent, sticker and oil emulsifier in insecticide, larvicide, etc. formulations.
TRITON X 45	6	An alkyl aryl polyether alcohol. Anhydrous nonionic, light amber coloured liquid, sp.gr. 1.03-1.05 at 25°C. Miscible with most organic solvents and considered miscible in all proportions with mineral spirits, VM and P Naphtha and diisobutylene. Essentially insoluble in water and only slightly soluble in highly refined aliphatic solvents and oils. Flash point 510°F (Cleveland open cup); mild, slightly aromatic odour. Indicated as emulsifying agent for spray oils and other emulsifiable insecticides.
TRITON X 100	6	An alkyl aryl polyethoxy ethanol. Clear, amber coloured viscous liquid of mild odour. Sp.gr. at 25°C 1.059-1.068. Flash point over 300°F. Excellent stability over wide pH range. Miscible with alcohol in all proportions and readily soluble in 50% glycerin. Insoluble in straight chain hydrocarbons; slightly soluble in aromatic

Product	Key	Indications of Manufacturer
TRITON X 100 (Contd.)	6	oils; readily soluble in cold water. Indicated as emulsifier for solutions of DDT, Rhothane D3, HETP, chlordane, chlorinated camphene, Lethane 384, Lethane 60, rotenone extract and others.
TRITON X 114	6	For addition to Bordeaux mixture at a concentration of 0.025% to improve spray dispersions applied to banana trees. It assists suspensions to spread evenly over the leaf surface and to leave uniform deposits upon drying. Deposits are also rendered more weatherproof.
TRITON X 151	6	A blend consisting of alkyl aryl polyether alcohols with organic sulphonates. Liquid anhydrous emulsifier of sp.gr. 1.04-1.06 at 25°C; viscosity approx. 200 Saybolt secs at 100°F. Soluble in most organic solvents including aromatic hydrocarbons such as xylene. Also soluble in aromatic petroleum derivative solvents. Relatively insoluble in petroleum fractions such as kerosene, etc. Soluble in many toxicant/solvent systems such as toxaphene/kerosene, chlordane/kerosene, etc. Indicated chiefly for use with Triton X 171 in order to form versatile emulsifier blends which will provide satisfactory performance for various toxicant/solvent systems in hard and soft waters.
TRITON X 155	6	An alkyl phenoxy polyethoxy ethanol. Anhydrous, nonionic amber coloured liquid of mild odour of sp.gr. 1.045-1.065 at 25°C. Viscosity 2100 secs at 100°F (Saybolt Universal Scale). Flash point 430°F. Soluble in aromatic petroleum solvents and in most other organic solvents with the exception of certain paraffinic petroleum fractions including insecticide base oils. Soluble in water below 75°C. Found useful for preparing emulsions in combination

Product	Key	Indications of Manufacturer
TRITON X 155 (Contd.)	6	with other emulsifiers (particularly Triton B 1956 and Triton X 45). Suggested for use in preparation of insecticide emulsions for application as residual sprays, mosquito larvicides, livestock dips, etc.
TRITON X 161	6	A blend of alkyl aryl polyether alcohols with organic sulphonates. Liquid anhydrous emulsifier, amber clear, of sp.gr. 1.04-1.06 at 25°C; viscosity approx. 500 Saybolt secs at 100°F. Range of solubilities similar to X 151. It is suggested for use in pesticide formulations to be applied primarily in medium hard water areas (60-300 ppm approx.)
TRITON X 171	6	A blend of alkyl aryl polyether alcohol type and organic sulphonate type surfactants. Liquid anhydrous emulsifier of sp.gr. 1.04-1.06 at 25°C. Viscosity approx. 625 Saybolt secs at 100°F. Range of solubilities similar to Triton X 151 (q.v.) Triton X 171 alone is recommended for preparing toxaphene/kerosene and other systems for use in soft water.
UNEMUL	24	A smoothly gelatinous form of hydrated aluminium oxide prepared by a special process of rapid 'ageing', (Brit. Pat. No. 487,855), to develop its emulsifying, wetting and suspending properties. It is capable of forming emulsions in water of almost all immiscible liquid materials (e.g. horticultural oil sprays) and of hydrophobic solids liquefiable at or below 100°C. Its emulsions have no tendency to reconstitute after being broken on a surface and dried. It can be used to render wettable the surface of normally water-repellent substances (e.g. sulphur), and as a conditioner and suspending agent for finely dispersed powders (e.g. DNOC).

Product	Key	Indications of Manufacturer
VANTOC AL	16	Aqueous blend of higher alkyl trimethylammonium bromides (10% active agent). Cationic straw coloured liquid which solidifies on cooling below 0°C. Dissolves in cold or, more readily hot water forming chemically stable neutral solutions. Bactericidal.
VANTOC B	16	12.5% aqueous solution based essentially on tetradecyl pyridinium bromide. Cationic, pale golden liquid forming slightly acidic chemically stable solutions in hot or cold water. Bactericidal.
VANTOC N	16	Blend of higher alkyl trimethyl ammonium bromides (over 90% active). White powder, chemically stable, forming neutral solutions in hot or cold water. Powder is slightly hygroscopic. Bactericidal.
VANTROPOL BQ	16	Combination of nonionic detergent with quaternary ammonium bactericide. Amber coloured clear liquid.
VYKAMINE L.M.E.	7	Lauryl monoethanolamide (100% active). A cream coloured wax, soluble in ethyl alcohol, paraffins, chlorinated solvents, benzene and homologues. Wetting, softening and dispersing agent.
VYKAMOL 1B	7	Sorbitol mono-laurate. Water dispersible, nonionic ester. Use to prepare O/W emulsions with Vykamol 6 B. Insecticide spreader, penetrating agent or wetting agent.
VYKAMOL 2B	7	Sorbitol mono-palmitate. Stabiliser for O/W emulsions. Insoluble in water, soluble in many organic solvents. Use in insect repellent creams and liquid paraffin emulsions.
VYKAMOL 3B	7	Sorbitol mono-stearate.

Product	Key	Indications of Manufacturer
VYKAMOL 4B	7	Sorbitol mono-oleate. Useful O/W emulsifier. Chemically stable. Use in miticide emulsions.
VYKAMOL 5B	7	Sorbitol tri-oleate. Oily liquid soluble in most organic solvents. Stabiliser for O/W emulsions. Wetting agent and W/O emulsifier.
VYKAMOL 6B	7	Ethylene oxide/sorbitol mono-laurate derivative O/W emulsifier, soluble in water and many organic solvents, insoluble in petroleum ether and mineral oils. Especially effective in conjunction with Vykamol 1B. Wetting, solubilising, penetrating agent. Insect repellent emulsions.
VYKAMOL 8B	7	Ethylene oxide derivative of sorbitol mono-stearate. Soluble in water and many organic solvents. Use in preparation of O/W emulsions especially in conjunction with Vykamol 4B.
VYKAMOL 10B	7	Ethylene glycol derivative of sorbitol mono-oleate. Soluble in water and many organic solvents excluding mineral oil. Effective O/W emulsifier especially in conjunction with Vykamol 4B.
VYKAMOL 12B	7	Ethylene oxide derivative of sorbitol tri-oleate, dispersible in water. Soluble in many organic solvents to varying degrees. Wetting, solubilising and penetrating agent.
VYKAMOL DGMS	7	Diethylene glycol mono-stearate. White opalescent, nonionic waxy solid soluble in hot alcohol, hydrocarbons mineral and vegetable oils. Emulsifying, wetting, dispersing, binding and lubricating agent. m.p. 55°C. Acidity 5%.

Product	Key	Indications of Manufacturer
VYKAMOL GMS	7	Self emulsifying glycerol mono-stearate. Lump or powder. White to light cream product. Aids suspension of pigments in oils, etc. Acts synergistically on other surfactants.
W 303	31	Technical thickening agent. Can be mixed into lead arsenate wash as follows: W.303 4% gel. 100 parts by wt. Lead arsenate 2 " " " Water 300 " " " The gel is made by vigorously stirring W 303 into water at 60°C.
ZYLAPOL DLB	17	Alkyl aryl sulphonate liquid (over 30% active matter). To improve stability of liquid emulsions; wetting, penetrating and foaming agent.
ZYLASIL BX	17	Dialkyl aryl sulphonic acid paste (40% active matter). Wetting and dispersing agent.
ZYLASIL WET	17	Dialkyl ether sulphonate liquid (60% active matter). Wetting and spreading agent. Effective in low concentrations.

Key

1. A. Boake, Roberts & Co. Ltd.,
Carpenters Road, Stratford, London, E.15.

2. Abril Industrial Waxes Ltd.,
Golden Mile Works, Bridgend, Glam.

3. Armour Chemical Industries Ltd.,
4, Chiswell Street, Finsbury Square, London, E.C.1.

4. B. P. Detergents Ltd.,
Britannic House, Finsbury Circus, London, E.C.2.

5. Burt, Boulton & Haywood Ltd.,
Brettenham House, Lancaster Place, Strand, London, W.C.2.

Key

6. Charles Lenning & Company (Great Britain) Ltd.,
26-28, Bedford Row, London, W.C.1.

7. C. M. Keyworth & Co. Ltd.,
Barnfield Works, off Newcastle Road, Leek, Staffs.

8. Croda Ltd.,
Cowick Hall, Snaith, Goole, Yorks.

9. Gemec Chemicals Co. (Division of Union Carbide Ltd.),
120, Moorgate, London, E.C.2.

10. Glovers (Chemicals) Ltd.,
Wortley Low Mills, Wortley, Leeds, 12.

11. Guest Industrials Ltd.,
81, Gracechurch Street, London, E.C.3.
[Agents for Liljeholmens Stearinfabriks - A.B., Stockholm].

12. Hardman & Holden Ltd.,
Manox House, Miles Platting, Manchester, 10.

13. Hercules Powder Company Ltd.,
1, Great Cumberland Place, London, W.1.

14. Honeywill-Atlas Ltd.,
Devonshire House, Mayfair Place, Piccadilly, London, W.1.

15. Howards of Ilford Ltd.,
Ilford, Essex.

16. Imperial Chemical Industries Ltd.,
Nobel House, London, S.W.1.

17. Keegan Dyestuffs & Chemicals Ltd.,
164, Garnett Street, Bradford 3, Yorks.

18. Lankro Chemicals Ltd.,
Bentcliffe Works, Salters Lane, Eccles, Manchester.

19. Manchester Oil Refinery Ltd.,
Twining Road, Trafford Park, Manchester, 17.

Key

20. Marchon Products Ltd.,
Whitehaven, Cumberland.

21. Murphy Chemical Co. Ltd.,
Wheathampstead, St. Albans, Herts.

22. Norman Evans & Rais Ltd.,
Dudley Road, Manchester, 16.

23. Plant Protection Ltd.,
Yalding, Kent.

24. Rex Campbell & Company Ltd.,
7, Idol Lane, Eastcheap, London, E.C.3.

25. Ronsheim & Moore,
8, Buckingham Palace Gardens, London, S.W.1.

26. Shell Chemical Company Ltd.,
Marlborough House, 15/17, Gt. Marlborough Street, London, W.1.

27. Sipon Products Ltd.,
23, Dryden Chambers, 119, Oxford Street, London, W.1.

28. Thomas Swan & Co. Ltd.,
Consett, Co. Durham.

29. Union Carbide Ltd. (Chemicals Division),
103, Mount Street, London, W.1.

30. Vitax Ltd.,
Burscough Bridge, Ormskirk, Lancs.

31. Watford Chemical Company Ltd.,
22/32, Copperfield Road, London, E.3.

32. Joseph Weil & Son, Ltd.,
Friars House, 39-41, New Broad Street, London, E.C.2.
[Agents for Berol Aktiebolag, Göteborg, Sweden].

NEWS ITEMS

HORTICULTURE IN THE BRITISH COMMONWEALTH, AN OUTLINE 1958

"The aim of this compilation is to collect under one cover information which is otherwise only available in very numerous annual reports, journal articles and memoranda. This information concerns not so much outstanding events as humdrum everyday performance. The bureau is often asked where work is being done on particular problems and what work is in progress in particular countries and at what research or experimental centres. Here is an attempt to give a rather general answer to such questions. It is based mainly on information given for the purpose by the Official Correspondents of the bureau in different countries."

Many important pest and disease control measures are included.

(D. Akenhead. Tech.Comm.No. 26, Commonwealth Bureau of Horticulture and Plantation Crops, East Malling, Maidstone, Kent. pp.63.)

INFESTATION CONTROL - A SERVICE TO AGRICULTURE AND FOOD STORAGE

Farmers, seed merchants, millers and many others connected with agriculture and the food trade who are aware of the widespread damage done by insects and other pests to stored products and by harmful mammals and birds to growing crops will welcome a new publication - "Infestation Control" ∅ - issued by the Ministry of Agriculture, Fisheries and Food, which gives an account of the scientific work undertaken by the Infestation Control Division of the Ministry in the field of research into ways and means of controlling these pests.

This attractive and well-illustrated booklet describes fumigation and other modern methods of dealing with stored products insects, new methods for controlling rats and mice, the measures now in operation for the control of land pests - with particular reference to the rabbit - harmful birds, and the historical background over the last forty-five years.

A brief outline of the Ministry's Regional Service with a map showing the present regional boundaries is included. A reference list of scientific papers published during the past sixteen years by the staff of the Infestation Control Division provides a useful guide to the scope of this important aspect of the Ministry's work.

(∅ "Infestation Control. A Service to Agriculture and Food Storage." 32 pages, 12 plates of photographs. Obtainable from H.M.S.O. or through any bookseller. Price 4s. (by post 4s. 5d.)).

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE (IN GREAT BRITAIN)

Recommendations, for the safe use in agriculture and horticulture of the compounds noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Endrin on Blackcurrants.	Revised March 1959.
Fluoroacetamide (Agricultural and Horticultural Use).	Issued May 1959.
Morphothion. (OO-dimethyl S-(morpholinocarbonylmethyl) phosphorothiolothionate). (Agricultural and Horticultural Use).	Issued April 1959.
Phenylmercury Salicylate Aerosols. (Agricultural and Horticultural Use).	Issued April 1959.
Simazine. (2-chloro-4:6-bisethylamino-1:3:5-triazine). (Agricultural and Horticultural Use).	Revised March 1959.

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

INTERNATIONAL AGRICULTURAL AVIATION CONFERENCE

An account of the activities of the European Agricultural Aviation Centre (E.A.A.C.) founded last July has already been given in this journal (see 4, (4), 427-9). One of its prescribed functions is to organise periodical Agricultural Aviation Conferences. The first of these these is being held at the College of Aeronautics at Cranfield from 15th to 18th September and will consist of three full days for papers and discussion followed by one day's flying demonstration. The programme is being organised jointly by:

The Ministry of Agriculture, Fisheries and Food

The Society of Chemical Industry

The Ministry of Transport and Civil Aviation

The Colonial Office

The European Agricultural Aviation Centre, The Hague, Netherlands

The Royal Aeronautical Society

The National Farmers Union

The Association of British Manufacturers of Agricultural Chemicals

The Fertiliser Manufacturers Association

The National Association of Agricultural Contractors

It is proposed to cover the following aspects:-

First Day. Introductory Paper: Review of Development in Agricultural Aviation.

AGRICULTURAL CHEMICALS AND FERTILISERS INCLUDING BIOLOGICAL EFFICIENCY

1st Session	Physical Qualities of Dry Agricultural Chemicals intended for Aerial Application
2nd Session	Liquid Carriers and Solvents used in Aerial Spraying-Progress Report Session (Including Biological Aspects)
3rd Session	The Drift Hazard. Physics of Falling Droplets and Particles Progress Report Session.

Second Day. AIRCRAFT, EQUIPMENT AND CORROSION PROBLEMS

1st Session	Aircraft: The Operators Requirements Progress Report Session
2nd Session	Distribution Equipment Progress Report Session (Evaluation of Various Types of Equipment)
3rd Session	International Airworthiness Standards Progress Report Session
4th Session	Corrosion Problems Progress Report Session

Third Day. ECONOMICS AND FLYING

1st Session	Economic Factors Affecting Agricultural Aircraft Operations Progress Report Session
2nd Session	Safety Precautions Progress Report Session

3rd Session Techniques of Low Flying
Progress Report Session
4th Session Ground Organisation and Equipment
Progress Report Session

The fourth day is occupied by a flying demonstration of planes and equipment, organised by the National Association of Agricultural Contractors.

The official languages for the Conference will be English and French.

The Conference fee, inclusive of accommodation, meals, hospitality and gratuities, will be £14. There will be no extra charges. The fee will also entitle registered members to one copy of the Proceedings.

Registration forms may be obtained from the Ministry of Agriculture, Fisheries and Food, Room 218, Great Westminster House, Horseferry Road, London, S.W.1, or from Dr. W. J. Maan, Director of the European Agricultural Aviation Centre, le v.d. Boschstraat 4, The Hague, Netherlands.

It is expected that up to 250 delegates, representing research, development, advisory and commercial interests, will attend the Conference, including approximately 100 from O.E.E.C. member countries.

COLORIMETRIC DETECTION OF DIELDRIN AND ENDRIN

A recent communication to the Editor of Chemistry and Industry (see issue of April 25th 1959, p.539) by E. J. Skerrett and E. A. Baker (Long Ashton Research Station, University of Bristol) refers to a new colour reaction for endrin and dieldrin.

The method, it is stated, depends first on heating benzene solutions of the insecticides with boron trifluoride-diethyl ether complex to form a ketone derivative. Red colours are then produced by the action of tetraethylammonium hydroxide on ethanolic solutions of the corresponding 2:4-dinitro-phenylhydrazones produced in the usual way. Under controlled conditions as little as 10 µg. of these materials can be visually detected by this method, whereas as much as 1 mg. of DDT or BHC gives no colouration. The colour reaction is stoichimetric and its use in the determination of spray residues of these insecticides on plant materials will be reported elsewhere.

Toxicity of Dieldrin to Man

Dieldrin is widely used as a residual insecticide in malaria eradication campaigns. Instructions are issued to spray squads to use it with certain precautions because of its toxicity, but the spraymen are not always as careful as they might be about exposure to the insecticide.

Dieldrin is freely absorbed by the skin, dry dieldrin being absorbed about as easily as dieldrin in solution. It is less than twice as poisonous by mouth as it is when absorbed by the skin, in this respect differing considerably from DDT. The oral toxicity of dieldrin is three to five times greater than that of DDT, but DDT in solution is not readily absorbed by the skin and dry DDT is absorbed to such a small extent that its toxicity is not apparent.

The toxicity of dieldrin when absorbed through the skin has not, in the WHO consultant's, (Dr. Wayland J. Hayes Jr.), view, been fully appreciated. All the unclothed skin of a sprayman (and, to a lesser extent, his clothed skin also) is subject to constant contamination during spraying operations. This "imperceptible" contamination is in addition to obvious contamination from spilt dieldrin or from direct contact with the powder or suspension. Chemical measurements of imperceptible contamination reveal its extent and show the relative unimportance of respiratory exposure. These measurements are of special importance because it has commonly, and incorrectly, been assumed that the major source of dieldrin poisoning is respiratory exposure. Dieldrin is indeed poisonous if it is inhaled, but nearly all the dieldrin in water-dispersible powder is in particles that are too large for inhalation.

On the assumption that man is as susceptible to poisoning by dieldrin as experimental animals are, the mist of dieldrin which falls on the unprotected face and lower arms of spraymen is sufficient to account for the degree of poisoning which has been observed. This is not surprising; during the working day this mist, although imperceptible as it falls, often accumulates on the exposed skin sufficiently to form a visible residue. A given dose of dieldrin is absorbed more readily by a large than by a small area of skin. Consequently, an increase in the area of skin exposed not only increases the dosage received but also facilitates absorption.

There is clear evidence of a direct relationship between the dosage of dieldrin received and the occurrence of poisoning. The greater the concentration of dieldrin suspension used in spraying, for example, the greater is the chance of poisoning after a period of exposure. Moreover, the greater the area of bare skin exposed, the more likely is poisoning to occur. Again, the longer spraymen work under conditions which can lead to poisoning, the greater is the total incidence of poisoning. Immediate washing of the contaminated skin protects in part; delayed washing offers distinctly less protection.

One of the general principles of toxicology is that even the most poisonous compound may be used if adequate safeguards are provided. For that reason each worker hired for spraying operations should be told that he is working with a dangerous compound which has produced serious illness. The symptoms of dieldrin poisoning should be described in detail and the protective measures required outlined. There should be rigid supervision to ensure that hands, face, and all exposed skin are washed at frequent intervals, even though no contamination is visible, and that the entire body is washed with soap and water at the earliest practical moment after work has finished for the day. Free soap should be made available for this purpose. Working clothes should be washed daily with soap and water. The spraymen should wear shoes and socks, and a uniform that protects them as completely as possible and includes a veil of plastic netting. These precautions have already been stressed by a WHO Study Group on the Toxic Hazards of Pesticides to Man, ∅ and should be carefully observed.

In addition, sprayers must be kept in repair to prevent leakage; measuring cups, funnels, and other devices should have handles, so that workers can use them without touching dieldrin powder or suspension; and sprayers should be used at the lowest pressure consistent with effective control. There should be safety officers, and spraymen and mixers should not be permitted to work more than 8 hours a day or 40 a week. When a person has had dieldrin poisoning he should be taken off work with that particular insecticide, and he should be followed up medically for at least two years, and preferably longer.

Dangers of Insecticide Spraying

An experiment to determine the exposure of spraymen to insecticides has been carried out with DDT in the Communicable Disease Center, Wenatchee, Wash. U.S.A. The main area of exposure from indoor surface

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∅ Wld.Hlth.Org.tech.Rep.Ser., 1956, 114.

spraying is the upper trunk and upper extremities, and in this experiment these received about 1755 mg of DDT per hour of spraying. The average respiratory exposure was about 7.1 mg of DDT per hour of spraying, which is approximately equal to an inhalation of 3.4 mg of DDT per hour. The total potential exposure daily is 105 mg/kg for a worker who actually sprays for four hours of his eight-hour working day. It has been found in experiments that rats, which may or may not be more susceptible than human beings, can usually withstand the repeated daily exposure of 100 mg/kg of DDT to the skin but are killed as a rule by 200 mg/kg.

Various factors influence the amount of exposure. The lower the pressure of the spray pump the less the exposure. When an operator sprays surfaces above his head the exposure is greater; if the surfaces are roughened, absorbent, or have already been sprayed, the exposure is less. It is increased with temperature, or when a water-dispersible powder is used rather than an emulsion.

In the Taveta-Pare area of East Africa where dieldrin is used, spraymen are exposed to 1.8 mg of dieldrin per kg of body-weight daily for 180 days a year, with an interval of two months between spraying c cycles. There have been no cases of poisoning.

In Ecuador, Venezuela and Nigeria, however, 9%, 18% and 10% of the workers, respectively have suffered from dieldrin poisoning. In explanation it is pointed out that the East African spraymen work on an average only six hours a day, and for only 180 days a year. Their overalls are washed daily, and 225 g of soap is issued to each man every week. In Venezuela, some men worked as much as 15 hours daily for seven days a week, with no break between spraying cycles. In Nigeria, hours and spraying cycles were much the same as in East Africa, but clothing was not washed as frequently and only 60 g of soap was issued every two weeks. Elsewhere, overalls are not worn at all and the amount of skin exposed is much greater. There is considerable variation in the degree of observation of precautions.

Various trials were made in East Africa before the protective clothing at present used was adopted as a routine. It consists of a cap of impermeable material with a curtain round the back of the head, which buttons at the neck in front, and a plastic visor from the forehead down; drill overalls to the wrists and ankles; and rubber gloves of medium thickness. Tennis shoes should be worn in preference to gumboots, since the latter are hard to clean. This clothing resembles that found suitably protective in the American experiment, except that in the latter a sun helmet and a plastic netting veil were regarded as more effective than a cap and visor, because the helmet is light and does not interfere with the circulation of air - a most desirable characteristic in a hot climate - and netting is easier to clean.

(WHO Chronicle, 1959, 13, (3).)

Malaria Eradication Urgency and Needs

"With the development of resistance by mosquito vectors to commonly used insecticides in different areas, malaria eradication has become a race against time. In fact, there are indications that the insecticides now available may become ineffective within five to ten years. A programme of malaria eradication operations in many countries of the world for the period 1958-1962 has therefore been drawn up by the WHO, in co-operation with the governments and the other international agencies concerned. If it is successfully completed, "malaria eradication will have reached an advanced stage in many of the stricken areas of the world and some 500 million people, hitherto at risk, may be free from the danger of the disease."

The sum required for malaria eradication during the next five years is estimated at approximately $600 million. Of this, about 55% will be contributed by the governments of the malaria-stricken countries, and a further 35% is anticipated from such sources as the United States International Co-operation Administration (ICA), USA Loan Capital, and the United Nations Children's Fund (UNICEF). To provide the remaining 10%, WHO will have to raise approximately $50 million from voluntary contributions, as well as covering part of the sum through its regular budget and the Expanded Programme of Technical Assistance. As the organization responsible for the over-all planning of the world-wide programme, WHO "has furthermore to encourage research, provide advisers, consultants and other experts to governments, assist in national planning and in the training of local personnel and extend any further assistance that may be required in the organization and implementation of eradication projects."

To enable the Organization to meet these responsibilities, the Eighth World Health Assembly established the Malaria Eradication Special Account (MESA) to be financed by voluntary contributions from governments and private sources. A similar fund - the Special Malaria Fund of the Pan American Health Organization (PAHO) - has been established to finance eradication programmes in the Region of the Americas. Both funds are distinct from the regular WHO budget and the funds provided under the Expanded Programme of Technical Assistance. The estimated total expenditure for the operations planned to be financed from these funds for the period 1958-1962 is $48,512,835.

Contributions to the Malaria Eradication Special Account and the PAHO Special Malaria Fund can at present be raised only in the economically more developed countries. WHO therefore appeals urgently to these countries and their institutions to supplement the efforts of the less privileged countries to rid the world of malaria. In the words of the pamphlet: "The capital invested in eradication programmes will be regained in a few years. And once eradication is achieved, the world community as a whole, richer and poorer members, will benefit"."

(WHO Chronicle, 1959, 13, (2), 71-73.)

AGRICULTURAL RESEARCH IN THE U.S.A.

(1) New Cattle Grub Systemic

A new experimental organophosphorus insecticide (DOWCO-109) chemically, O-(4-tert-butyl-2-chlorophenyl)O-methyl methylphoramidothioate, was tested on Hereford yearlings by either spraying or administering orally in the fall. When examined the following spring, the animals were practically free of *Hypoderma* grubs; controls were infested normally. Pills or capsules gave 94-100% protection and the spray 99-100%.

(Agricultural Research, Feb. 1959, 7, (8), 15.)

(2) Mealybug on Apricot

The grape mealybug, *Pseudococcus maritimus* Ehr., a common pest of grapes and pears, has been causing damage to apricots, mainly due to the excretion of honeydew. Colonies are formed in the depression around the stem end of the fruits and the honeydew produced runs over the sides of the fruit. The black smut fungus which grows in the honeydew gives the fruit an unsightly appearance and a reddish tint.

Trials with three different timings of sprays were conducted in an orchard divided into three sections, A, B and C. Fall treatments were applied to A in September using malathion, Trithion-EK, Phostex and parathion in a light medium oil at 550 gal./ac. Winter sprays were applied to B in January using diazinon, Trithion-EK, Phostex and parathion in a dormant oil at 600 gal./ac. Spring treatment of C was conducted at petal fall in March with Sevin, Trithion, diazinon and parathion, without oil, at 650 gal./ac.

In general the fall and winter treatments were less effective than the spring sprays. Of the compounds used, parathion and diazinon gave the best control, regardless of the timing of treatments. None of the sprays caused any serious phytotoxic effects to the trees. A petal fall spray of either parathion or diazinon seems the most feasible method of control.

(H. F. Madsen and L. B. McNelly, California Agriculture, 1959, 13, (2), 13-14.)

3. (a) New Acaricides Against Parathion Resistant Mites

Trials with new acaricides (mainly phosphates) available in 1958 were made against the European red mite, Panonychus ulmi Koch in an orchard, consisting of a mixed stand of Winesap and Red Delicious apples, where the mites were known to be resistant to parathion and malathion.

Each plot consisted of four trees with three replications in a randomized block design. Materials were applied with a conventional high pressure spray rig and orchard guns. At each application the applied gallonage averaged 450 gallons per acre. The first treatments were applied on May 1, as the mite population had reached an economic level. Counts were taken at intervals throughout the season by picking 100 leaves at random from each treatment. The leaves were run through a mite brushing machine, and the mites counted under a binocular microscope. Spray applications were made on May 1, on May 29 and again on June 24.

Two nonphosphate compounds - Karathane and Tedion - were included in the trials. Karathane, a fungicide, was used in an apple powdery mildew control schedule, and was applied four times at approximately 14 day intervals. Tedion was used only once, on May 29, and was applied to the plot which had been the untreated check.

Following the third spray on June 24, any plot which showed more than five mites per leaf was considered to have an economic level of infestation and was re-treated with a nonphosphate compound. The table expresses the data in terms of how many days the materials held the mites in check after the last application. If any material failed to hold the mites for a minimum of 30 days following three sprays, it was considered as a failure.

Trials of New Phosphate Compounds Against Parathion Resistant Mites on Apples, 1958

Material	Dosage/100 gal.	Applications	Days ø
Guthion	3 lb. 12½ WP	3	27
Trithion	1 lb. 25% WP	3	13
Trithion	½ pt. 50% fl	3	13
Ethion	1 lb 25% WP	3	13
Phosdrin	1½ pt 25% em	3	13
Monsanto 10516	1 pt 25% em	3	13
Monsanto 12452	1 pt 25 em	3	13
Monsanto 10739	1 pt 25% em	3	61
Karathane øø	½ lb 25% WP	4	27
Tedion øø	1 lb 25% WP	1	87

ø No. of days between last application and economic infestation.

øø Nonphosphate compounds.

All the phosphate compounds - with but a single exception - did not give adequate control of the parathion resistant mites after three treatments. Monsanto 10739, an experimental systemic phosphate was the only compound which provided good control. Mite populations were heavy on this plot late in the season, however, which indicates that a resistance problem would probably develop with additional treatments. Guthion held the mites in check for a longer period than some of the other materials tested, but still it did not give a satisfactory control.

Karathane required retreatment after four sprays, which indicates the compound either has a short residual effect or does not act against the summer eggs of the mites. Tedion was applied to the check plots when the mite population had reached an injurious level. Although the material was very slow in killing adult mites, as four weeks elapsed before the population declined, the single application kept the mites in check for the rest of the season.

The mite count was made 13 days after the last sprays were applied on June 24. The mite counts were very high on some of the plots, indicating that the last treatment had failed to give any measure of control. Although the table indicates that the materials held for 13 days, it was obvious that an economic level of population was reached before that time. In most cases post-spray count was higher than the count made prior to the last treatment.

These data indicate that although there may be some differences in the action of new phosphate acaricides against a strain of mite already resistant to the commonly used phosphates, there is little hope that resistance will not develop in a short time. With the increase of phosphate resistance in the case of European red mite, it seems necessary to look to other compounds for control.

3. (b) Effect of These Materials on Apple Aphid

Counts of *Aphis pomi* De G. were also made on the 1958 plots throughout the season. Even though the sprays were not timed for aphid control it was possible to evaluate the new materials mentioned above against apple aphid. With a schedule of three treatments, Monsanto 10739 was the only compound that held the aphids at a low population level for the season. Guthion and Trithion gave a good initial kill and held for about 30 days. Monsanto 10516, Monsanto 12432, ethion, and Phosdrin provided initial kill, but reinfestation took place within 1-2 weeks after application.

(H. F. Madsen and J. B. Bailey. California Agriculture, 1959, 13, (4), 12.)

4. Newly Found Disease Kills Citrus Red Mites

A disease, now believed to be caused by a virus, was observed in mites collected near Oxnard, California. In laboratory tests, the disease was found to be transmissible from sick and dead mites to healthy populations. The disease was also spread to healthy mite colonies by spraying them with water suspensions, prepared from ground-up diseased mites and passed through filter paper. The disease takes from 7 to 18 days to manifest itself, depending probably on the concentration of inoculum introduced and the temperature. All stages of mites, except the eggs, appear to be susceptible. Field trials are planned to find if new infections can be initiated in the field and whether mites can be controlled effectively with sprays containing the newly discovered pathogen. Studies are also planned to find out more about present distribution of the disease.

(U.S. Department of Agriculture P.M. Release, April 29, 1959.)

5. Codling Moth Investigations

New materials have recently been tested against codling moth, Carpocapsa pomonella L., on walnuts. Both Guthion and Sevin - neither released for commercial use on walnuts - showed promise in two applications. Guthion at six pounds of 25% wettable powder per acre for each application has tended to give better control than obtained with DDT. Further, Guthion has a suppressing action on spider mites and the walnut aphid. Sevin at eight pounds of 50% wettable powder per acre for each application has resulted in control equal to that obtained with DDT. Although Sevin tends to suppress the walnut aphid population it may - as DDT does - induce an increase in the spider mite population.

Trithion at one pound per acre has not given adequate control of the codling moth when used alone. However, in combination with DDT, to control the walnut aphid and spider mites, Trithion has a tendency to improve the control of the codling moth.

Ethion at high dosages has shown promise in controlling the codling moth, but has not equalled DDT. Delnav also has resulted in insufficient control.

(A. E. Michelbacher and C. Q. Gonzales. California Agriculture, 1959, 13, (4), 11, 14.

6. Can Oil Stop Fungi?

Although oil sprays are widely used for insect control, its use in controlling Sigatoka leaf-spot disease of bananas is unusual. (Oil is applied in pure form as a mist at the rate of 1 to 3 gal./acre.) A curious fact is that oil apparently does not attack the fungus directly. In fact, it was found that the fungus grew well in oil culture and on oil-coated leaves. Oil inhibits the fungus only after it enters the leaf. It is believed that the oil may have a unique mode of antifungal action. While studying the development of the fungus (Mycosphaerella musicola) on leaves and in culture, it was found that the oil had no significant effect on mycelial growth, germination of conidia and ascospores, penetration of germ tubes into leaves, ascospore discharge, or conidial spore formation. Growth of the fungus was arrested at only one stage in its life cycle - after the organism entered the leaves but before disease symptoms appeared.

The tests were made with two petroleum spray oils similar to those used on various crops for insect control, as well as with a pharmaceutical mineral oil, and a chemically inert silicone (a synthetic oil). Effectiveness of the latter suggests the oils act on a physical rather than chemical basis. The exact mechanism of control, however, is not yet understood.

(Agricultural Research, May, 1959, 7, (11), 11.)

7. (a) Cotton Insect Control

In field cage experiments Guthion 0.25 lb./acre gave more residual control of boll weevils than 0.5 lb. of malathion or 0.25 lb. of methyl parathion. Mixtures of chlorinated hydrocarbons and phosphate insecticides gave more effective residual control of boll weevils than either type material used alone.

In field plot tests Guthion was the most effective material tested for control of boll weevils. Malathion 0.5 lb./acre gave effective control of boll weevils when applied on a 3-day schedule. Sevin was the most effective new material tested. The spray formulation of this material was phytotoxic to the cotton plant.

7. (b) Fly Control

Malathion sugar baits have been successful in controlling houseflies in dairy buildings as granules and paints. Paint-on baits of Co-Ral and malathion resulted in high mortalities of flies anout hog parlors, but in situations where no source control was in effect it did not eliminate the problem.

7. (c) Cattle Lice Control

Of several insecticides tested as residual sprays, Dicapthon was the most effective against sucking lice. Complete control was obtained at 0.1% but not at 0.05%. None of the toxicants used as oral drenches provided appreciable control of lice.

(Mississippi Agricultural Experiment Station. 71st Annual Report-Fiscal Year ending June 30, 1958.)

STUDIES RELEVANT TO THE CONTROL OF PESTS
SCIENTIFIC RESEARCH IN BRITISH UNIVERSITIES 1957-58

From material compiled by the British Council, sponsored by Department of Scientific and Industrial Research, and published by H.M.S.O. London, 1958.

BELFAST (QUEEN'S UNIVERSITY)

Department of Agricultural Zoology

R. Chamberlain R. J. Willis A. R. Edwards	Field and laboratory studies on the biology and economic importance of crop pests. Evaluation of the relative effectiveness of newly developed insecticides under N. Ireland conditions. Investigations on plant parasitic nematodes with special reference to potato root eelworm.

Department of Crop and Animal Husbandry

Professor J. Morrison R. W. Hale W. E. Coey	Practical trials with selective weedkillers.

Department of Mycology and Plant Pathology

Professor A. E. Muskett, O.B.E. Dr. J. Colhoun J. C. Taylor E. L. Calvert C. W. R. McCreary	Investigations of seed-borne fungi which behave as crop parasites; control of crop diseases caused by seed-borne parasites; diseases of potato (blight, dry rot, virus diseases), flax (seedling blight, stem-break and browning, rust, wilt), fruit (apple scab, strawberry root rots and virus diseases), vegetables (club root of Brassicae), grasses (blind seed disease of ryegrass), rose diseases, dahlia diseases, diseases of glasshouse crops (tomato leaf mould), the fungus flora of N. Ireland.

BRISTOL UNIVERSITY

Agricultural and Horticultural Research Station, Long Ashton

Agriculture

Dr. J. T. Martin	Chemistry of insecticides and fungicides.
Dr. E. Somers	Physico-chemical properties of spray materials.
Professor H. G. H. Kearns, O.B.E.	Fruit pest control:
Dr. S. H. Bennett	Biology of insect pests.
N. G. Morgan	Techniques of spray application.
A. Stringer	Mode of action of insecticides.
Dr. C. G. L. Furmidge	Physical chemistry of spray materials.
H. R. Mapother	Assessment of spray materials for tropical crops.
T. E. Cobbald	Spray application to tropical crops.
R. W. Marsh	Fruit disease control:
Dr. R. J. W. Byrde	Bio-assay of fungicides.
Dr. A. T. K. Corke	Perennation of fruit-disease fungi.

Horticultural Science Laboratories

V. W. Fowler	Biology and control of certain pests of horticultural plants.

CAMBRIDGE UNIVERSITY

School of Agriculture

A. Lazenby	Studies of various weeds in relation to their control by agricultural practices.
Dr. P. H. Lowings	Root diseases of cereal crops.
Dr. C. R. Ribbands	Ecology and behaviour of sugar beet pests: honeybees.
T. D. Williams	Resistance of some potato species to potato root eelworm.

Zoology
Sub-Department of Entomology

Professor V. B. Wigglesworth C.B.E., F.R.S.	Insect physiology.
Dr. M. G. M. Pryor	Insect cuticle.
Dr. J. W. L. Beament	Wax secretion and water transport; microtechniques of surface chemistry; physiology of eggs.
Dr. W. A. L. David	Action of systemic insecticide.

EDINBURGH UNIVERSITY

Agricultural Botany

R. G. Heddle	Studies on weeds and weed control.
Dr. J. B. D. Herriott	Diseases of potato tubers and sugar beet seedlings.
D. S. C. Erskine	
L. S. Cobley	Skin spot disease of potatoes.
P. C. Harper	Club root disease of Brassicae.
Dr. A. E. W. Boyd	
Dr. J. H. Lennard	
W. A. Hughes	

Agricultural Entomology and Forest Entomology

J. W. McHardy	Agricultural and forest pests.
Dr. W. J. Guild	
D. R. Gifford	

LIVERPOOL UNIVERSITY, SCHOOL OF TROPICAL MEDICINE

Entomology and Parasitology

Professor R. M. Gordon	Early stages of development of parasites in the vertebrate host The *in vitro* culture of trypanosomes.
Dr. W. E. Kershaw	Filariasis in man and animals, and in the vectors. *T.spiralis* infections. Ageing
Dr. M. M. J. Lavoipierre	The transmission of filariasis by arthropods. Mites of medical and veterinary importance. The biting habits of mosquitoes under laboratory conditions.
M. J. Clarkson	Coccidiosis in turkeys.
Dr. W. A. F. Webber	*Onchocerca* in cattle. *Loa loa* in monkeys.
S. Barrett	Demodectic mange.
G. Dickerson	Early stages of development of certain helminth parasites in the vertebrate host.

LONDON UNIVERSITY, IMPERIAL COLLEGE

Chemistry Organic

Dr. L. Crombie	Chemistry of natural insecticides.

Zoology and Applied Entomology

Professor B. G. Peters	Parasitology.
Dr. A. B. P. Page	Insecticides, especially fumigation.
Dr. W. F. Jepson, O.B.E.	Insect pests of crops, especially stem-borers.

Botany, Plant Technology and Plant Physiology at East Malling Research Station

F. W. M. Llewelyn	Spray damage in fruit trees.

LONDON UNIVERSITY, WYE COLLEGE

Hop Research - Plant Pathology

H. S. Darling (Head of Department)	Studies on the incidence of the hop Aphis and its control by systemic insecticides.
Dr. Dorothy Derbyshire	Studies on hop downy mildew disease

Physical Sciences

Professor R. L. Wain Dr. Margaret St. Smith D. R. Williams Dr. F. Wightman Dr. C. H. Fawcett Dr. D. M. Spencer Dr. G. G. Clarke F. Taylor Miss B. Pybus Dr. G. L. Mattok	Plant growth substances: chemical structure in relation to physiological activity; movement of growth substances and their stability within plant tissues; mode of action. Fungicidal and systematic fungicidal activity.

LONDON UNIVERSITY, LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Entomology

Professor D. S. Bertram	Experimental filariasis; virus transmission.
Dr. J. R. Busvine	Laboratory studies on insecticides.
H. S. Leeson	Mosquitoes.
Dr. B. R. Laurence	Mosquito biology.

Tropical Hygiene - Ross Institute

Professor G. Macdonald, C.M.G. G. Davidson Miss C. E. Jackson	Epidemiology of malaria: Basic theory. Action of insecticides. Synthesis of resistance to insecticides in anophelines Analysis of resistance; genetic studies.
Dr. B. B. Waddy	Onchocerciasis

MANCHESTER UNIVERSITY

Pharmacy

Professor K. Bullock	Antiseptics, fungistats and fungicides.
Dr. C. Melville	Infestation of vegetable drugs with special reference to mites

READING UNIVERSITY

Agricultural Chemistry - Insecticides

Dr. K. A. Hassall	Toxicity in relation to physical and chemical properties of organic compounds

UNIVERSITY OF WALES, UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

Agricultural Botany

D. W. Parry	Effect of plant growth regulating substances on meristematic tissues in oat seedlings

Agricultural Chemistry

Dr. I. Antice Evans	Metabolism of herbicides by soil micro-organisms

Agricultural and Forest Zoology

J. Hobart (Lecturer in charge)	Biology of forest pests.

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA

Insecticide Investigations

Evidence has been obtained that the resistance of houseflies capable of dehydrochlorinating DDT is increased by exposing them to sub-lethal concentrations of DDT during the larval stage. As this implies individual adaptation to DDT, a phenomenon not previously recorded, new techniques are being developed to differentiate between adaptive and selective effects of DDT during the larval stage.

Variations in susceptibility with ageing of insects have been studied, by using water-soluble insecticides applied by a new injection method which promises to be rapid and precise.

Relationship between chemical structure and insecticidal activity have been examined in two groups of compounds, namely, volatile ketones and *N*-substituted amides of long-chain fatty acids.

Tick Control

Resistance: Cattle on a central Queensland property where ticks had become DDT-resistant were subjected to ten months' dipping in BHC and four months' dipping in dieldrin. These ticks were resistant to dieldrin, and retained their former degree of DDT resistance. A DDT-resistant strain reverted to a low-order resistance, and a dieldrin-resistant strain reverted to almost complete susceptibility during culturing for fourteen and eight generations respectively. Spraying of infested animals with the respective acaricides resulted in one generation in a return to high resistance of the previously dieldrin-resistant strain, and a slight increase in resistance of the reverted DDT-resistant strain.

Persistence: The reason for the brief persistence of diazinon on cattle hair is being studied. There was a marked correlation between persistence and coat density, and the winter coats of cattle may retain an effective deposit of diazinon for ten times the period that it persists on the short summer coats. The deposits persisted no longer on cattle shaded in stalls than on cattle grazing in the open. No evidence of evaporation from the hide was obtained, nor did chemical breakdown of diazinon occur on cattle hair at various humidities *in vitro*. Loss of diazinon by absorption into the skin is being investigated by radiotracers. It was confirmed that formulation has a pronounced effect on the size of the initial DDT deposit left on the coats of cattle, but there is no significant difference in the persistency of effective deposits. Degreasing the coats of cattle before spraying did not increase the persistency of DDT.

Testing of Acaricides: A mixture of 0.5% pp'-DDT and 0.05% diazinon in a dipping vat continued to give effective tick control. A new bioassay technique showed that there is no synergistic action between the diazinon and the DDT. Bayer "21/199" was tested in a dip as a wettable powder at 0.05%. It was highly toxic to cattle ticks, afforded a protective period of 4-7 days, and was stable in the dip. A malathion emulsifiable concentrate was more toxic to ticks than emulsions and wettable powders tested previously.

Molluscicides

Copper pentachlorophenate has proved to be a more effective molluscicide against Simlimnea subaquatalis than copper sulphate. It is formulated as a 30% dispersible paste and applied by high volume spray at the rate of 10 lb. per acre in 400 gal. of water by means of a boom spray and lance coupled to a bushfire fighting pump. The removal of vegetative cover and the institution of effective drainage of springs and swamps are also necessary. The snails can survive dry periods for some months, and spraying is best carried out when there is ample surface water.

Mothproofing

The SI-RO-MOTH'D process of mothproofing with dieldrin has become widely used in Australia and the method is becoming very popular also in other countries. Goods may be treated for less than 1d. per lb. Attempts to stabilize the wool fibre against biological and chemical attack by treating it with carbodiimides to introduce new peptide cross-links were only partially successful.

Insect Viruses

Exploratory work has been started on several new diseases of insects. A granulosis of caterpillars of a moth Doratifera, and a polyhedral disease in larvae of an Emperor gum moth have both been investigated. A very interesting disease showing a relationship with Rickettsia melolonthae appeared in the eucalyptus snout beetle, Gonipterus scutellatus. The discovery of this disease may prove important economically, for the snout beetle is still a serious pest of eucalyptus in some countries despite the importation of parasites from Australia.

Agricultural and Horticultural Pests and Diseases

Apple Scald: Continuing trials have shown that wraps containing 1.5 mg diphenylamine were still effective in controlling scald eighteen months after preparation. Pre-harvest spraying at 2,000 p.p.m. became ineffective two days after treatment, but the material could be applied simply and effectively as a post-harvest spray prior to packing. No other substances tried were as effective as diphenylamine.

Superficial Scald: Large-scale experiments have confirmed the complete effectiveness of diphenylamine as an inhibitor of scald, provided that adequate amounts are applied, either by dipping or by enclosing the apples in diphenylamine impregnated wraps. Work on pre-harvest spray treatment is continuing. If human toxicity studies by the United States Department of Agriculture result in diphenylamine for fruit being cleared by public health authorities, it will be recommended to the industry. The roles of ventilation and fruit volatiles in scald development are still under investigation.

Citrus: Protection against mould in oranges stored for longer than three-four weeks has been achieved by following the sodium orthophenylphenate "rinsed" treatment with a skin coating of 0.5% sodium orthophenylphenate in wax emulsion. This combines the effective mould treatment with the advantages of waxing. A new method of applying wax coatings, "foam waxing", appears to be economical, simple, and advantageous to established packing houses.

Red scale, *Aonidiella aurantii*, is by far the most important pest of citrus in Australia and field control is far from satisfactory. High natural mortality has been observed during heat waves, so heat treatments ranging from 50-70°C were given for varying times, freshly picked Washington Navel fruit parasitized with red scale being used. All time/mortality curves were sigmoidal and similar to dosage/mortality curves normally obtained in entomological control studies. Reliable 100% "kills" were obtained for treatment periods ranging from 1 hour at 70°C to 2¼ hours at 50°C. Raising humidity from 11% to 40% did not alter mortality rates, which suggest a temperature rather than a dehydration effect.

Crucifers: The most important pests of crucifers are the cabbage moth, *Plutella maculipennis*, the cabbage white butterfly, *Pieris rapae*, and the cabbage aphid, *Brevicoryne brassicae*. The biological control of these has been given much attention in recent years, with considerable success in the case of *Plutella* and *Brevicoryne*.

In the past year the possibility of using insect pathogens has been considered. An extremely virulent virus disease of *Pieris* has been discovered in the field, This has been cultured in the laboratory and successful field experiments have been conducted with it. A field search has also been made for diseases of *Plutella*. The most promising so far discovered is a fungus disease.

Lucerne Flea and Red-Legged Earth Mite: A survey of the results of commercial aeroplane spraying operations against both pests revealed that control was either excellent or satisfactory in 91% of treatments against the lucerne flea, and in 99% of treatments against the red-legged earth mite. The unsatisfactory results appeared to be due principally to the use of equipment producing very fine droplets . (mostly less than 100 μ) when a high proportion of the spray was lost in drift.)

Tobacco Blue Mould, *Perenospora tabacina*: The looper moth, *Plusia argentifera*, may be a factor in the spread of this disease between fields. Glass-house experiments have shown that blue mould in seedlings can be controlled by the use of benzol vapour even though infection has taken place.

Dried Fruits: Further assistance has been given to the dried fruit industry following the successful introduction last season of methyl bromide fumigation of fruit arriving at the packing sheds. This season the industry has agreed to the adoption of film spraying, with pyrethrum in a non-volatile carrier oil, of all packed fruit in order to protect it from infestation by the Indian meal moth, *Plodia interpunctella*.

Timber Pests and Preservation

Diffusion Treatments: Development of cheap diffusion treatments for building and joinery timbers has continued. Patent application has been made for a range of borofluoride preservatives, with or without arsenic, suitable for dip treatment of green timber in very concentrated solutions, followed by block-stacking to permit diffusion of chemicals into the wood. In laboratory tests of these preservatives, control of decay and termites has been equal or superior to that obtained by more costly pressure treatment with a copper-chrome-arsenic preservative. Field tests are in progress to determine the extent of penetration necessary in building timbers to control termites. Semi-commercial tests at sawmills using a non-arsenical borofluoride in dip-diffusion treatment for control of *Lyctus* have given satisfactory results.

Lyctus: Various surface treatments were tested for the prevention of *Lyctus* attack. After two years' indoor weathering chlordane, lindane, aldrin, and dieldrin are still completely effective.

Termites: Field tests of surface treatments which have been in progress for three years have shown that pentachlorophenol remains effective against *Nasutitermes exitiosus*, but other materials failed after two years. Tests of soil treatments for termite control are continuing: against *N. exitiousus*, lindane, chlordane and tetrachlorobenzene have so far given complete protection for three years; against *Coptotermes lacteus*, dieldrin and chlordane have so far given complete protection for four years, and aldrin and tetrachlorobenzene for three years. Similar tests against a termite complex in the Riverina have shown that pentachlorophenol, sodium pentachlorophenate, chlordane and creosote have so far given complete protection for five years.

Rabbit Control

Work on the European rabbit flea, *Spilopsyllus cuniculi*, which has been imported under quarantine in the hope that it would provide a myxomatosis vector that was not dependent on water for its breeding, has been disappointing. The insect has been found both in Britain and Australia, to be the reverse of amenable to laboratory culture. Five consignments of pupae have been received from England, from which a total of 412 adults emerged. A quarter of these were successfully established on wild rabbits held in the laboratory. Some of them survived up to three months, fed continuously, and were shown to have mated; but no females succeeded in maturing eggs, despite the manipulation of temperature and humidity to provide conditions more closely appromating to the insect's natural environment. The Department of Health has now been approached for permission to breed the insects outdoors in a warren enclosure.

As a preliminary to an assessment of the value of lures in rabbit poisoning, an attempt is being made to determine the role of the rabbit's sense of smell in the location and selection of food. Results obtained to date support the indications obtained from other enclosure experiments that scent plays a less important part in bringing rabbits to food than is generally believed and that the main value of lures or decoys often incorporated in baits is probably as an appetizer rather than a long-distance attractant. Work on poisoning is being intensified, and studies have commenced on the length of dangerous "life" of sodium fluoroacetate ("1080") baits and on bait preferences under varying seasonal conditions.

(Tenth Annual Report of the Commonwealth Scientific and Industrial Research Organization for Year 1957-58.)

Plunge Dipping: Two experiments were done in Western Victoria with 1,992 Merino ewes to determine protection obtainable against breech strike by plunge dipping in arsenic, dieldrin or diazinon. During 17 weeks after dipping, 0.02% diazinon gave a significantly greater protection than arsenic (0.13% As_2O_3). Ewes dipped in 0.01% diazinon or 0.025% dieldrin were protected to a comparable degree. It is suggested that dipping has a place on overall fly-strike control programmes.

("Prevention of Breech Strike in Merino Ewes Plunge Dipping in Dieldrin and Diazinon." W. J. Pryor and K. D. Skerman. Australian Vet. J., 1959, 35, (1), 13-15.)

Lucerne

Author's summary: Experiments are described which demonstrate effective insecticidal treatments for the control of the lucerne flea, Sminthurus viridis (L.) and the red-legged earth mite, Halotydeus destructor (Tuck.)

As dual purpose insecticides, malathion/DDT, malathion/lindane, and endrin all gave excellent results. The lower cost and lower mammalian toxicity of malathion/DDT favour this mixture, which is now recommended for field use. Also effective against the lucerne flea were dieldrin, chlorthion, and diazinon. Lindane and Dilan gave good control of the red-legged earth mite, but DDT was superior to both. None of the materials used for the control of the lucerne flea had an effective residual action, so that careful attention to the time of application of the insecticides was essential for optimum results. Treatment within 3-5 weeks of the rains which initiate hatching of the oversummering eggs is recommended. Eradication was not achieved by any of the treatments.

The subsequent effect of insecticidal treatment on the population density of both pests is discussed. The numerical changes which followed the application of insecticides suggest that density-governing factors play an important part in the regulation of the numbers of both species.

("Insecticides for the Control of the Lucerne Flea, Sminthurus viridis (L.) and the Red-Leged Earth Mite, Halotydeus destructor (Tuck.), and Their Effects on Population Numbers." M. M. H. Wallace. Australian J. Agric.Res., 1959, 10, (2), 160-170.)

AUSTRALIA - QUEENSLAND

Wood Preservation: The Board approved the use of the proprietary preservative "Celcure" as an approved preservative against *Lyctus brunneus*, as required by the Timber Users' Protection Acts. Whole house fumigation against European house borer, *Hylotrupes bajulus*, with methyl bromide has been carried out in 850 State owned houses built of imported coniferous timber. The treatment has been entirely successful in killing the larvae at present infesting the timber. Check inspection has not revealed any occurrence of a generation born in Queensland and there is good reason to believe that the fumigation treatment will result in eradication of this insect.

(Annual Report of the Department of Forestry for the Year 1957-58.)

AUSTRALIA - VICTORIA

Citrus - Mediterranean Fruit Fly, *Ceratitis capitata*: It is stated that DDT is still the best control spray in Queensland and in New South Wales where the recommendation is 0.2% DDT applied every 7-10 days commencing as the fruit starts to ripen. Dipterex is showing promise for control on stone fruit. A malathion bait, developed in Florida, has been shown to be better under Australian conditions than the standard tartar emetic and sugar bait.

(J. Agriculture, Victoria Dept.Agric., 1959, 57, (1), 15.)

Termite Control - Preventive Measures: The four principle species of termites attacking structural timber in Victoria are: *Coptotermes acinaciformis*, *C.frenchi*, *C.lacteus* and *Nasutitermes exitiosus*. Where buildings are erected on stumps termite resistant timber should be used and metal barriers, in the form of caps constructed from 24-gauge galvanised iron, fitted to isolate them from the soil. On masonry foundations a metal barrier in the form of a continuous strip of galvanised iron resting on the damp-proof course is used. Excellent protection is also given by construction of buildings on concrete slab floors, but creosote or other repellent chemicals should be applied at junctions and the soil against the slab edges should be similarly treated. At least a 3 in. apron is required so that any termite communication tubes may be seen and broken. Creosote oil may be used in temporary structures, the oil being painted over the surface of stumps, and other timber standing in the soil, from the base to a height of 12 in. above ground level. A layer of soil, at least 2 in. wide and 6 in. deep, around the timber should be treated with creosote or repellent chemicals such as 1% benzene hexachloride, 1% dieldrin or 2% chlordane emulsions. Butts of round timber may be successfully treated by immersion in creosote oil heated to 212°F for four hours and then allowed to cool.

Infestation in Buildings: Low and large mound nests should be dug up completely, broken up and burnt. If a nest exists in a tree, the tree may be cut-down and the nest destroyed or $\frac{1}{2}$ oz. finely powdered arsenic may be blown via an auger hole into the centre of the nest and the hole then plugged with mud.

The control of termites by means of poisonous powders or dusts is not recommended for general use. Where it is not possible to work beneath the floor of an infested building or where, for other reasons, treatment of the foundation is impossible or very inconvenient, poison dusts may be used as a last resort. The most effective chemical is powdered white arsenic, which is blown into a gallery.

("Termites (White Ants) and Their Control" H. B. Wilson.
J. Agriculture, Victoria Dept.Agric., 1959, 57, (1), 35-53.
and 57, (2), 89-95.)

AUSTRALIA - WESTERN

Citrus: Pink wax scale, *Ceroplastes rubens* Mask. White spraying oil at the rate of 1 gal. to 40 gal. water, or 2 tablespoons to 1 gal. water, as used against most citrus scales will kill the crawlers of the pink wax scale. Once the waxy covering is well developed, however, a soda spray is necessary and the following mixture is recommended:

White oil	1 tablespoonful	(1 gal.)
Soda ash	4 oz.	(10 lb.)
or		
Washing soda	$\frac{1}{2}$ lb.	(20 lb.)
Water	1 gal.	(40 gal.)

Spray treatments should be given after the main hatching has been completed - early December for the first brood and at the end of March for the second brood. The spray should not be applied during a heat wave. Foliage burning may follow its use on some delicate plants.

(C. F. H. Jenkins. J.Dept.Agric.Western Australia, 1959, 8, (1), 25-6.)

CEYLON

Tea: Shot-Hole Borer, *Xyleborus fornicatus*: Experiments were carried out in which the lower parts of tea bushes were sprayed with chlordane and dieldrin. This method of spraying is based on observations which showed that a number of adult beetles appear on the lower parts, that entrances to the galleries made by the borer also occur here, and that many adult beetles traverse the lower parts of the bush. It was also thought that this type of spraying would largely eliminate chemical contamination of plucked tea, and at least partly, the destruction of Macrocentrus homonae, the controlling parasite of tea tortrix.

Chlordane was used in the form of a miscible oil formulation at a strength of 3.75% of the technical chlordane and dieldrin was used as 0.5% spray in the form of emulsion. The individual bushes were sprayed first around the outside at heights of 6" or 12" above ground level, and afterwards the spraying lance was put inside the lower parts of the bushes at a hieght of 6" or 12". Not only were the lower parts of tea copiously sprayed, but also some part of the soil surface adjacent to the tea bushes.

At the 6" level 110 gal./acre of spray liquid was used and at the 12" level, 245 gal./acre. Results showed no significant differences in the degree of reduction of numbers of live adults between plots sprayed once at these heights. When tea of the average approximate height of 3 ft. at 14, 15, 18 and 20 months after pruning, was sprayed once at heights of 6" and 1 ft. above ground level, there was a considerable reduction in the number of live adults 2½, 3, 6, 7, 8 and 9 months after treatments.

("Preliminary small-scale field experiments on a chemical method for the prevention of shot-hole borer (Xyleborus fornicatus Eich.) attack on tea in plucking." E. Judenko. Tea Quarterly, June 1958, 29, Pt. II, 115-124.)

MALAYA

Dieldrin Resistance in Culex fatigans: After two years' dieldrin spraying of houses, in a small isolated kampong near Kuantan as part of the filariasis investigations, C.fatigans was found to have developed strong resistance. Laboratory tests using the new WHO Standard test kit, showed a 100-fold resistance to dieldrin in unfed adults and in 4th stage larvae of fatigans, and a 20-fold resistance of the larvae to BHC; there was little resistance to DDT.

Reversion of BHC Resistant Strain of C.fatigans: The strain of C.fatigans from Penang, that was found in 1953 to have developed a tenfold resistance to BHC used as a larvicide, has been maintained since then in the laboratory at Kuala Lumpur without further exposure to insecticide. A year after the original tests, when in the 10th generation, it was found to have lost much of its resistance though the LD_{50} for BHC was still twice that of a susceptible strain. When the strain was re-tested in the 43rd generation, all resistance had disappeared.

Anopheline Susceptibilities: *Anopheles barbirostris*: Adults of the dark-winged form, which is a vector of malaria and filariasis, were raised from eggs laid in the laboratory and tested the day after a blood meal, with the standard kit, to determine their susceptibility to DDT and dieldrin. The LD_{50} for DDT was found to be 1.3%. This is about three times the figure for *A.maculatus* (0.4%), and thus fits in with the results in window-trap huts where the usual dose of DDT (200 mg per sq.ft.) is only effective for about two months against *barbirostris*, compared to six months against *maculatus*.

Persistence of Dieldrin: Trials with window trap huts in 1953 had shown that dieldrin at 40 mg per sq. ft. was still killing over 80% of *A.maculatus* six to seven months after treatment, when the trials had to end due to the usual seasonal decline in numbers of *maculatus*. An attempt was made to follow this up and find out how long dieldrin could be made to last against *maculatus*. A window-trap hut was treated in July, 1955, with dieldrin wettable powder at 100 mg per sq.ft. The hut remained unoccupied for 20 months and was then brought into operation again. Allowing for a natural mortality of 15%, a 72% kill was attributed to the dieldrin. It is pointed out that in an occupied house, where the deposit would be subject to more wear, the effective period would presumably be less.

Filariasis: After the commencement of six-monthly pilot control residual spraying of houses with dieldrin (100 mg/sq.ft.), in Kampong Ubai in November, 1954 the microfilaria rate fell from 38% before spraying to 31%, and the mean microfilaria count from 11.5 to 8.2. This drop only occurred in the last year. In surveys of children, born since the start of residual spraying, the microfilaria rate in 1956 was 8% (1/12), and in 1957 was 5% (1/18). The latter represents the microfilaria rate in children of the 0-3 age group, which in surveys prior to control in this kampong was 23% (10/44). These results suggest that some interruption of transmission has occurred.

A large scale experimental spraying with dieldrin was carried out in Paula Rusa. The mature infection rate of *Mansonia longipalpis* was reduced from 0.7 to 0.3%.

(Annual Report of the Institute for Medical Research for 1957.)

Cabbage: The results of an experiment on the control of the diamond back moth, Plutella maculipennis Curt. confirmed that DDT and BHC are no longer effective against this pest. Almost complete control of the caterpillar was obtained with 0.04% diazinon spray, applied at weekly intervals from transplanting until two weeks before harvest. Dieldrin at 0.15% a.i. also gave good results but is not recommended because of considerable residues. Laboratory tests indicate that control of flea beetle, Phyllotreta sinuata Redt. can be obtained by frequent applications of 0.1% diazinon or malathion sprays.

Cacao: A test has been completed to compare the amount of residual deposit on cacao foliage given by dry fogging, wet fogging and mist blowing. A method of employing a fluorescent tracer was used. Results indicate that either type of fogging gives little deposit on the foliage, and that only on trees close to the line of fogging. The amount of deposit given by these methods of application and its distribution over the leaves would not, it is considered, give an effective coverage of insecticide. Mist blowing is a more efficient method of distributing the same amount of material evenly over the foliage to give a residual deposit.

Oil Palm: In laboratory tests various insecticides were compared and endrin was found to be the most effective against the bagworm, Cremastopsyche pendula, a 100% kill of larvae being attained by spraying with a mixture containing 0.3% active ingredient.

The main problem in the control of this pest in the field is to find an efficient method of applying the insecticide to tall mature palms. Dusting with a power duster and fogging with a TIFA machine have not proved successful. During the year an estate in Perak carried out aerial spraying and approximately a thousand acres were sprayed using endrin at about 4 oz. per acre. Three days after spraying the highest kill of larvae found on sample trees was 48% with an average of 30% for all palms sampled. Results of this spraying, although not giving a very high mortality rate were considerably better than any previously obtained by other methods.

Pineapple: Mealybug wilt studies continued. Tests on the disinfestation of pineapple suckers by immersion in diazinon insecticidal solutions have given promising results. Immersion for five seconds in a solution containing 0.025% diazinon followed by stacking the suckers in an upright position for 24 hours resulted in complete disinfestation of most suckers both in laboratory and field tests. Only heavily infested suckers with mealybugs around the base, outside the leaves, were not completely freed from infestation.

Rice: An attempt is being made, by recording detailed counts of borer attack, to discover a method of predicting, early in the season, the probable intensity of stem borer attack later in the season. Insecticidal measures can then be applied if considered economic.

Tea: Helopeltis can be controlled by spraying or dusting with DDT. A trial has been laid down to discover whether fogging, using a portable fog generator, would give cheaper control.

An experiment to find the least expensive method of controlling blister blight, Exobasidium vexans, with a fungicide is in progress. Three copper fungicides are being used, applied respectively by spraying, dusting and fogging.

(Annual Report of the Department of Agriculture for the Year 1957.)

NEW ZEALAND

Army Caterpillar Control: In the late autumn of 1956 and again in the autumn of 1957, army caterpillar, Pseudaletia separata and Persectania aversa, devastated more than 120,000 acres of steep hill pastures.

Effective sprays applied by helicopter or aeroplane per acre were: $1\frac{1}{2}$ pints of 15% dieldrin in 5 to 10 gallons of water, more water being used according to the rankness of growth; 2 pints of 20% DDT in similar quantities of water.

The fact that the main hatchings of eggs, which gave rise to the immense populations of voracious caterpillars on the move in search of fresh feed, took place in relatively small patches of over-rank grass high in the hills some 2 or 3 weeks before the movement began suggests that had any of these infestations been noted and the danger appreciated at this early stage spraying of such areas would have been much less costly and far more effective in preventing damage.

(C. J. Hamblyn. New Zealand J.Agric., 1959, 98, (4), 329-333.)

Bird-Repellent Seed Dressings: Results from a pilot nursery trial indicate that anthraquinone compound has considerable powers as a deterrent to bird attack when applied to Pinus radiata seed, and also appeared appreciably to reduce the severity of post-emergence attack on young seedlings. A cold emulsifiable asphalt was used as a sticker, and while this did not affect the germination of stratified P.radiata seed, it proved unsatisfactory with stratified Pseudotsuga taxifolia seed. Red lead powder dusted on to water-dampened seed was also tested and was found to be only slightly less effective both in preventing seed damage and in lessening post-emergence attack on seedlings. Red lead powder in itself had no effect on germination. There seem to be grounds for supposing that any abnormal colour imparted to seeds provides a certain immunity from bird attack, and this idea is being tested.

A small field trial of direct seedling of a clear-felled forest area showed that anthraquinone seed dressings had no repellent effect on field mice, and red lead possibly only a slight effect.

Wood Preservation: Laboratory testing of fungicides for sapstain control was continued. Mixtures of sodium pentachlorophenate and borax are the most satisfactory for stain prevention. For long periods of block stacking, i.e. three months or more, decay fungi are likely to become active, and higher retertions than those normally used are recommended for long-term protection.

(Forest Research Institute. Annual Report for the year ending 31st March, 1958.)

SOUTH AFRICA

Locust Control: The results of small-scale field tests with BHC sprays and dusts against the brown locust have been analysed. The main conclusions are that most economical and effective means of killing locusts is by spraying rather than dusting. In North Rukwa about 2,000 acres moderately heavily infested with red locust hoppers were sprayed from the air by the lattice method, which involves spraying in strips as opposed to solid blocks. Most promising results have been obtained with dieldrin sprayed from the air in strips at right angles to and crossing each other. Effective mortality was obtained when such strips were laid down at intervals of as much as 250 and 500 yards. Per acre of target area the amount of insecticide used is extremely small.

Red-billed Finch Control: The spraying of grain with parathion was found to be an excellent method of control. This method of control is fairly expensive however, and unfortunately not very effective when the principal crop is threatened by large concentrations. With smaller local populations, the spraying of one or two morgen of early grain crops may play a vital part in controlling the finch population. As it is, this scheme has already met with considerable success in the Winter Rainfall Region.

Forest and Timber Pest Control

Pine Brown-tail Moth, Euproctis terminalis: In trials in 1956-57 DDT gave the best results of several insecticides tested. Excellent control was subsequently obtained with aerial applications of DDT, dissolved either in water or diesoline at 1 lb./acre.

Emperor Pine Moth, Nudaurelia cythera capensis: Commercial control was obtained by aerial sprays of endrin in diesoline or water. Work on the egg parasite Mesocomys pulchriceps has shown it to be of importance in the control of the moth. During aerial spraying - August to November - most of the parasites are present as immature stages in the egg of the host. The adult parasite emerges during February to March when the residual deposits of spray have become attenuated or virtually non-existent. Thus, this parasite fits very conveniently into the control programme and takes over when the egg stage is the only one present at that time.

Chermidae (Psyllidae): In Pretoria these jumping lice cause heavy defoliation of Acacia caffra every summer. The most satisfactory spray is Metasystox but monthly applications are necessary.

Termite Control: The under-cover soil poisoning tests at Rustder-Winter, begun in 1949 to determine the most suitable poisons for treating sub-floors of buildings under construction to prevent termite access to the timbers above, were continued. The following treatments remain completely effective: 5% copper naphthenate, 5% pentachlorophenol, both in furnace oil.

Crop Pests and Diseases

Tobacco: It is stated that leaf blight, Erysiphe cichoracearum, can now be effectively controlled with Karathane.

Citrus: No improvement is recorded in the incidence of blackspot, Phoma citricarpa. Trials in the Eastern Transvaal show that some copper sprays and, especially Bordeaux mixture, can be made more effective in controlling black spot by the addition of oil (½%). Work is in progress on a study of the adhesiveness of copper fungicides on citrus leaves and the influence of spreaders like oil in making the copper residues last longer.

Deciduous Fruit: Mildew, *Oidium tuckeri*, and anthracnose, *Sphaceloma ampelinum*, of grapevines were severe in the Transvaal because of the unseasonable rains. In the Winter Rainfall Region wastage caused by *Botrytis cinerea* was common for the second consecutive year. Good control, especially in table grapes, was obtained by regular spraying with either captan or a mixture of captan and sulphur.

Several outbreaks of scab in apples and pears, *Fusicladium dendriticum* and *F. pirinum*, occurred in some localities in the western Cape and were correlated with long periods of wet weather during blossoming. An epidemic was averted by the dry weather that prevailed from November onwards. Little control was effected by the usual fungicides, but in spraying trials better control was obtained from two new fungicides, coppercote and cyprex.

Conditions were very favourable for leaf curl in peaches, *Tephrina deformens*, and the disease was common in most areas. In field trials in the western Cape lime sulphur and ziram sprays gave better control than copper oxychloride, and copper preparations are now not recommended when the weather is favourable to the disease.

(Department of Agriculture. Annual Report of the Secretary for Agriculture for the period 1st July, 1957 to 30th June, 1958.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BERMUDA

Mediterranean Fruit Fly, Ceratitis capitata Wied.: During 1957 and 1958, a concentrated effort has been made to reduce the Mediterranean fruit fly population in Bermuda. This has been done by trapping, and the application of foliar and ground sprays. In these two years a total of eighteen thousand males were caught and destroyed in traps. The traps are baited with angelica seed oil which contains DDVP as the toxic agent. Foliar sprays contained malathion and a protein bait. Dieldrin was used in ground spraying. Trapping indicates that the fly population was greatly reduced in 1958 over 1957, the first year for a long period where consistent trapping was carried out. This is thought to have been brought about by the different control activities exercised in these two years. No damage to citrus by fruit fly was recorded in 1958.

Control of Land Crabs: During the summer of 1958, a full-scale field test was made to appraise the effectiveness of a recent recommendation for the control of land crabs Gecarcinus lateralis. This recommendation consisted in treating individual burrows with a bait composed of bran, dieldrin, salt and water. Some interesting results were secured:

1. Approximately 60% of the crabs in a treated area are killed in one or two days. The majority of the remaining 40% can be expected to die after two or three weeks inactivity in the burrows. Total kill approximates 85-95%.

2. The results secured are practically as good where the bait is broadcasted, as where individual holes are treated.

3. Two baitings of any given area during the summer months are recommended.

4. The amount of dieldrin recommended (½ lb. to 20 lb. of bran) was found to be about optimum.

Control of Flies in Dairy Farms: An experiment was conducted on the control of flies in dairy barns. A fly bait containing DDVP and 1% malathion has proved effective. This, used in combination with proper manure pits, would undoubtedly assist in reducing the fly population.

(Annual Report of the Director of Agriculture for the Year 1958.)

BRITISH GUIANA

Coconut: Spraying with 1% dieldrin solution is recommended against the coconut moth borer, Castnia daedalus. An outbreak of the locust, Tropidacris latreillei, was controlled by aerial spraying with 4 fl.oz. 18% dieldrin E.C. in 1 gal. water at the rate of 20 gal./acre.

(Director of Agriculture, Annual Report, 1957.)

KENYA

Barley Fly (Hylemyia arambourgi)

Aldrin and dieldrin dry seed dressings were tested and gave good control of the fly. Trials with a dressing of 50% endrin and an aldrin/organo mercurial dressing showed promise but gamma BHC gave no control. Spray trials indicated that dieldrin and endrin, at 8 to 9 oz. active ingredient and 6 oz. active ingredient respectively, gave some control. Aldrin spray had some effect but diazinon spray was less effective. Aldrin, gamma BHC and dieldrin wettable powders, at rates of 8 oz. active ingredient per acre in all cases, were tested as pre-planting sprays. In no case was a reduction of infestation noted.

Coconut, Pseudotheraptus wavi

Work on the biological control of this pest has so far proved unsuccessful. The predatory tree-nesting Oecophylla which, when present in large numbers, effects considerable control of the coreid bug, has not increased in numbers in a three-acre block from which all antagonistic ants were eliminated for a period of a year by insecticidal treatments. It is possible that under Kenya conditions Oecophylla populations are limited more by food availability than by antagonistic ants. In small hand-spraying experiments dieldrin has shown some promise at high concentrations, with a good residual kill.

Coffee

With the demonstration of the value of the insecticides malathion and diazinon against many serious coffee insect pests, particularly the sucking insects (Hemiptera), the leafminers, Leucoptera spp., and other moths, it is now possible almost to eliminate insecticides of long residual action from the spraying recommendations, so that there is less fear of interference with the complex of beneficial insects associated with coffee. Insecticides of long residual action, when applied as spray-bands against ants attending scale insects or white borer, are still essential, but are not recommended as foliage sprays.

Antestia, Antestiopsis spp.: Experimentation with malathion against *Antestia* continued and recommendations for its use were issued. A full account of this work was published in the Bulletin of the Coffee Board of Kenya in June, 1957.

Leafminers, *Leucoptera meyricki* Ghes. and *L. caffeina* Washb.: Experiments with insecticides and investigations into the life histories of these insects were pursued. Resulting from these studies it was found possible to achieve control of the moths as well as larvae within the leaves with diazinon and to control the moths with malathion. Suitable spray-timings were determined and recommendations for controlling these pests were published in the Bulletin of the Coffee Board of Kenya in December, 1957.

Coffee Lacebug, *Habrochila ghesquierei* Schout.: No infestations suitable for experimentation were found during the year. However, before completion of this report, a range of insecticides was tried. Of these, parathion was the best, but was very closely followed by malathion. In view of the hazards to spray operators associated with the use of the former insecticide, malathion is recommended for the control of lacebug. Two sprayings were found necessary, the second to be applied 21 days after the first in order to eliminate the population resulting from the relatively few eggs not killed by the first spray application. Malathion should be applied at a strength of one pint of the 50% emulsion concentrate in 40 gallons of water on each occasion.

In a trail of aerial spraying against *Antestia*, it was found that the two pints of malathion concentrate applied per acre by this means also had good effect on lacebug. The mortality of eggs was not, however, so great as is achieved by using ordinary spraying machines. It was, nevertheless, demonstrated that this method could afford a means of rapidly containing an attack. Research continues on this pest.

White Borer, *Anthores leuconotus* Pasc.: Field experiments evaluating the efficiency of dieldrin spray-bands were continued. It has now been demonstrated that three applications of ½% dieldrin applied previous to consecutive rains, i.e. over a period of 18 months, completely eliminates boring larvae. Dieldrin spray-banding is now recommended to growers whose coffee is infested by this insect.

Leaf Skeletoniser, *Epiplema* (*Leucoplema*) *dohertyi* Warr.:

Malathion 50% emulsion concentrate applied by tractor-drawn machines at a rate of two pints per acre gave good control of these moths and their larvae. Lead arsenate simularly applied at a rate of 2½ lb. per acre also gave excellent control of the larvae.

Cotton

Earlier trials using cotton dust 3:10:0(3% gamma BHC and 10% DDT) showed that good control of stainers (mainly *Dysdercus nigrofasciatus* and *D. superstitiosus*) could be achieved on early planted cotton by five applications each of 16 lb. per acre at 10-day intervals starting from the time when plants carried two bolls. While 3:10:0 cotton dust is known to give good stainer control this dust is costly, and means to reduce expense had to be considered. The three dusts tried were 10% DDT, 5% Crude BHC + 10% DDT, and 3% gamma BHC + 10% DDT. These dusts were applied at three different rates as follows:-

(1) Five applications of 16 lb./acre at 10-day intervals.
(2) Seven applications of 10 lb./acre at 7-day intervals.
(3) Four applications of 16 lb./acre at 12-day intervals.

Yields from the treatments in lb. seed cotton/acre are shown in the table. Control yielded 407 lb./acre.

	10% DDT	10% DDT 5% Crude BHC	3:10:0 cotton dust
5 Dustings at 10 day intervals	499.3	517.5	662.5
7 Dustings at 7 day intervals	610.1	525.2	611.9
4 Dustings at 12 day intervals	548.7	540.3	687.4

It was concluded that the dusts used did produce improved yields which more than paid the cost of the dusts and that the percentage of B grade cotton was, in most cases, cut by half as compared to the control. In most cases the increased return is hardly worth the effort of applying the dust while in others the increase is around Sh.70 to Sh.100 per acre. For consistently better returns, 3:10:0 cotton dust would appear to be the best.

Pyrethrum Thrips, *Thrips bacaci*

In most cases, two sprays of DDT at fortnightly intervals have proved effective, but on one or two occasions there have been failures. Trials have been commenced with various insecticides, but positive results have not so far been obtained. The trials have shown that diazinon, malathion and pyrethrum are not effective. In a later experiment dieldrin spray gave satisfactory control when applied at 7.5 oz. active ingredient per acre. In certain cases the frequent DDT treatment led to an outbreak of red spider mite, probably through the destruction of its natural predators. Malathion, at two pints to the acre in 40-50 gallons of water, seems to give reasonable control.

Stored Products

An experiment with cob maize held in a crib for 13 months corroborated the earlier findings that cob maize dusted with 0.06% gamma BHC (lindane) in local diatomite, at a rate of 8 oz./9 cu.ft., kept virtually without insect damage for over a year when the crib walls are covered with hessian, sprayed at the time of storing with 40 g lindane plus 4 g coumarone resin dissolved in kerosene, at the rate of 1 litre per 100 sq.ft. This method may be useful when cob maize for rations or stock feed has to be stored on farms for more than six months. The standard practice in Kenya is to dust cob maize after harvest with 0.5% lindane in diatomite (8 oz./9 cu.ft.) when stored in cribs with open wire-netting walls. This treatment gives almost perfect results for six months, but after 13 months about 20% damage was found in this year's experiment. Untreated maize had over 90% damaged grain.

An insect population study with different treatments of shelled maize in 200-lb. bags, carried out over 33 months, showed spectacular results with admixture of 0.3% pyrethrins plus 3% piperonyl butoxide in finely milled pyrethrum marc. At 8 oz. per 200-lb. bag the population was kept down to an extremely low level as long as the experiment lasted. At 4 oz. the treatment was equal to one part per million of gamma BHC. This experiment was carried out in a store with a very heavy infestation and where no specially cold season occurs.

A large-scale experiment was laid down in 1956. Four stacks, each containing about 3,000 200-lb. bags of white maize were built. Two of the stacks were surface dusted, layer by layer, with 0.5% lindane-diatomite powder at the rate of 3 oz. per bag. The other two stacks were sprayed with 1.5 lb. DDT per 1,000 sq.ft., layer by layer. One stack of each treatment stood on dunnage and the floor was treated with 10% DDT dust. The other two stacks stood on untreated floor. The stacks were fumigated with methyl bromide at the beginning of the experiment. After 13 months the maize was found to be in very good condition and pest infestation in all four stacks was small and mostly confined to the upper parts of the stacks. *Tribolium castaneum* and *Oryzaephilus surinamensis* were present but *Calandra oryzae* was absent. A statistical analysis could not establish any difference between the floor treatments. BHC dust was better against *Tribolium* than DDT spraying.

(Department of Agriculture Annual Report 1957. Volume II - Record of Investigations.)

Coffee Berry Disease: Results from trials over the past two years show that considerable yield increases can be obtained as a result of spraying with 4½ lb./acre of a formulation containing 50% Captan in about 200 gal. water.

(Note by F. J. Nutman, Kenya Coffee, 1959, *24*, (278), 47.)

MAURITIUS

Sugar

White Crub, Glemora smithi: Control trials were continued with aldrin and chlordane at 2-8 and 2-4 lb. a.i./arpent ø, respectively; emulsions and insecticide-fertilizer mixtures were applied to the furrows before planting, or emulsions were applied along the rows of germinated virgin cane and harvested ratoon cane.

Results, so far, indicate that aldrin is more efficacious than chlordane and that both have a residual action extending for two or three grub seasons. 4 lb. chlordane as emulsion to the furrow reduced infestation by 84% and 59% in the first and second grub seasons (first and second years after applications), respectively, while the corresponding figures for 2 lb. aldrin were 79% and 43%. The same formulations and doses applied along rows of ratoon cane after harvest resulted in 54% and 28% control with chlordane in the first and second years, respectively, and similarly 72% and 64% with aldrin. Application of insecticide dust-fertilizer mixtures to the furrow before planting gave a high degree of control in the single trial of this type where infestation occurred.

ø 1 arpent = 1.043 acre.

It is concluded that field use of these insecticides should be on an exploratory basis and at present restricted to furrow application of 1 lb. actual aldrin or 2 lb. actual chlordane at planting, using either emulsion or dust.

(Mauritius Sugar Industry Research Institute. Annual Report 1958.)

NIGERIA - FEDERATION

Forestry

Termites in Relation to Eucalyptus spp.: Termites are pests at all stages in the life of Eucalyptus. In the nursery the workings and voracity of termites on many sites, and particularly newly composted beds, can prevent the germination of seed and growth at any stage. Their activities can be further stimulated by covering germination beds with grass on certain sites and their climax of destruction is usually reached in the transplant beds during the second half of the dry season when the plants have least vigour. By raising seedlings in termite proof frames these difficulties are obviated but care must be taken to prevent termites entering receptacles after pricking out. When cement plinths are used there is little danger but on a large scale where receptacles have to be placed on the ground it is intended to carry out a routine treatment by treating the water with a proprietary insecticide. If this treatment is maintained each plant will be planted out with its own reserve of insecticide which will give some protection in the field.

Recent treatments of Macrotermes mounds with aldrin ($\frac{1}{8}$ pint of 40% emulsifiable concentrate, diluted in 6 gallons of water to each mound), costing 9d. per mound for the insecticide, have met with success and it is possible that such treatment may greatly reduce the incidence of attack in both nurseries and plantations. The technique used was to drill two or three $1\frac{1}{2}$ auger holes in each mound, angled downwards to penetrate the nest. A piece of hose pipe was then pushed down the hole and the insecticide poured in from a watering can.

A replicated trial has been laid down to test the efficacy of aldrin, dieldrin and BHC, when applied to planting holes at the time of planting Eucalyptus striplings in a Communal Forest Area on the Jos Plateau. Heavy rains and difficulties experienced when organising the planting may have reduced the value of this trial which is to be repeated next year.

(Department of Forest Research Officers' Conference, Ibadan 1957.)

NORTHERN RHODESIA

Cotton: Cotton yielded well on Mount Makulu despite being planted as late as 28th December. A yield trial of Gatooma-bred strains averaged 914 lb. per acre of high grade seed cotton. Insect pests were present but kept under control by weekly sprayings of endrin during the vulnerable period of the crop. Bacterial blight of cotton, *Xanthomonas malvacearum*, was present but not unduly damaging, and insects found included jassid, bollworms (*Earias* sp. *Heliothis armigera*, *Diparopsis castanea*) and *Calidea* and *Dysdercus* spp. but only American bollworm and jassid had the makings of heavy attacks. Cotton had not been grown in the district for many years, so far as was known, and it was therefore surprising to find red bollworm, which is specific to cotton, present on the cotton in the trial; but search soon revealed a few bushes of the quasi-indigenous Kidney cotton in the labour compounds, and it seems probable that red bollworm maintains a foothold on similar chance plants throughout the county. The Zambezi and the Luangwa valleys still grow a little cotton, and the crops are potentially heavy yielding but more often than not devastated by insect attack. Modern insecticides are to be tried on a range of exploratory plots in the valleys and on the plateau next season.

(Department of Agriculture. Annual Report for the Year 1958.)

SOUTHERN RHODESIA

Liver Fluke and Bilharziasis Campaign: "Following the considerable success of last year's pilot campaigns undertaken by the East Hunyani Group of I.C.A. Committees and the Soki I.C.A., a further considerable advance took place in the campaign sponsored by the Board to eradicate liver fluke and bilharziasis. This year a very fair percentage of Committees decided to treat all the permanent water (except major rivers) in their areas and obtained the support of the majority of landowners in their respective areas.

It has been authoritatively estimated that some 20% of European school-children in this Colony have bilharziasis, and to estimate the same proportion amongst the adult population is probably not inaccurate, while of the Native population - the country's main labour force - 80% are afflicted. It will therefore be seen that the control of both bilharziasis and liver fluke is of paramount importance, and that the first step must be the killing of the intermediate host, the fresh water snail. In this respect it is hoped that the effectiveness of the new practical snail killer, sodium pentachlorophenate, will greatly assist the campaign because it also kills the snail eggs, thus necessitating only one spraying."

(Report of the Natural Resources Board for the Year ended 31st December, 1958.)

SIERRA LEONE

Cocoa: An outbreak of "Swollen Shoot" disease of cocoa, the first to be recorded in Sierra Leone, was discovered in April 1958. No mealybug vectors (*Pseudococcus njalensis*) have been observed.

Experimental spraying against black pod disease of cocoa was continued for the third successive season at the private farm at Kpuaku and was, in general, effective in suppressing the disease. 1% Carbide Bordeaux gave better control than either 0.4% Perepod or 0.4% Kopapod. There was very little difference between the incidence of the disease in the control (unsprayed) plots and in plots which were underbrushed and diseased pods cut out periodically.

(West African Rice Research Station. Annual Research Report to Colonial Office 1958-59.)

TANGANYIKA

Tick Control: Preliminary investigations were made into the systemic use of insecticides. In order to evaluate the concentration of the gamma isomer of benzene hexachloride in the blood of animals, a rapid method for its estimation, sensitive to 0.1 mg per 100 ml. was devised.

The toxic effects of sub-cutaneous and intramuscular injections of a suspension of lindane in arachis oil was investigated and up to 150 mg/kg was found to have no noticeable toxic effect, even in young calves. Blood levels were, however, unsatisfactory, and it was found that the highest concentration reached was of the order of 0.8 mg lindane per 100 ml. of blood. It was interesting to note that the blood concentration showed a closer relationship to the volume of oil injected than to the amount of lindane used, indicating that the lindane in suspension was absorbed so slowly as to exert a negligible influence on the blood level during the first two weeks.

A small field trial was carried out using cattle exposed to natural tick infestation. At the levels used, blood concentrations reached 0.8 mg per 100 c.c. and although there was an apparent decrease in the tick burden, the trial was not successful in killing all attached ticks, or in preventing fresh infestation. Further work was planned, using other dispersing agents.

(Annual Report of the Veterinary Department for the Year ending
31st December, 1957, Vol. II - Research, Investigations and
Statistics.)

UGANDA

Malaria: Increasing interest is being taken in all districts in the control of malaria in rural areas, particularly in connection with the construction of new roads and dams. A clause is now included in all contracts for road-making requiring excavations to be left in such a state as to be self-draining. The advice of the entomologist is regularly sought at the planning stage of major new construction programmes where these may affect the breeding of mosquitoes.

Trypanosomiasis: In Lango, spraying of the River Aswa and its tributaries was continued with 6% dieldrin solution, the vegetation on the banks of the main river was treated using a power sprayer mounted on a dinghy and the tributaries by knapsack sprayers. From July onwards, barrier spraying was applied at two-monthly intervals to important branches at the periphery of controlled areas. By the end of the year, the fly in all parts of the area was at such a low density as to make further transmission of the disease most improbable. It is intended to continue this spraying until the number of new cases detected drops to its previously low figure. The cost of insecticide used during the year amounted to £4,700.

Onchocerciasis: Following a survey of the Bufumbo area in 1956 an attempt was made early in the year to secure effective control of Simulium neavei. Weekly applications of DDT were made in the form of "Arkotine" to 140 dosing points over a period of three months. The work involved very strenous physical effort. Many new paths had to be cut through the forest to reach the headwaters of smaller streams. It is therefore disappointing to report that although this measure resulted in a marked reduction in the number of fly caught, complete eradication failed. Expressed as flies per hour the incidence dropped from around 150 before the spraying to 10 afterwards: this low level was still maintained up to the end of the year.

Further investigations indicated the following reasons for the failure. Based on work elsewhere it had been presumed that S. neavei developed only in association with the crab P. niloticus which is confined to the more open streches of the larger, free-flowing rivers. It has now been demonstrated that on the west of Elgon the crab P. granviki is also involved, in the ultimate wet season tributary streams running through the densest forest cover. It has also been proved that the pre-adult life cycle is much longer than previously supposed. Dosing intervals of three to four weeks would probably be adequate, but because it is likely that the adult life is also extended, it might be necessary in a future attempt to prolong the dosing schedule for six months.

(Annual Report of the Medical Department for the Year ended 31st December, 1957.)

WEST AFRICA

Loiasis Research

Entomological Research: Work is in progress on the bionomics of Chrysops at Kumba in order to elucidate the importance of the different species as vectors of loiasis in man and monkey, and to obtain data on larval biology necessary for the proper implementation of insecticidal control in the field.

(i) Studies on adult Chrysops:- An analysis of a two-year series of 24-hour catches made on a tree-top platform in the Cameroons rain-forest has provided much information on the biting habits of C. langi and C. centurionis. These species bite almost entirely at forest canopy level during the evening twilight period and they show a marked seasonal abundance just at the end of the rains. The incidence of infection with Loa among them is significantly higher than among C. silacea and C. dimidiata but the mean number of developing parasites in individual flies is smaller. The strain of Loa carried by naturally-infected C. langi and C. centurionis have been shown to exhibit nocturnal microfilarial periodicity when inoculated into experimental monkeys and all the evidence suggests that these species are the main vectors of the nocturnally-periodic form of Loa that is naturally parasitic in monkeys.

A two-year study of the population densities and infection rates of C. silacea and C. dimidiata in Kumba forest has recently been concluded. The results domonstrate the difference in the seasonal biting densities of the two species and it is now possible to compute a comparative index of the monthly risk of infection from the bites of Chrysops at Kumba.

Forty six *C. longicornis* have been caught near Kumba while resting on vegetation or occasionally while attempting to bite man in the forest. Thirteen of these were fed on a monkey with microfilariae of *Loa* in its blood and were subsequently maintained in the laboratory until they died. They were then dissected and examined for filarial larvae. The larvae showed a slow and very irregular development, although one fly, which died 12 days after the blood meal, contained a number of infective larvae. The results indicate that *C. longicornis* is not a good vector of loiasis.

Work continues on the effect of filarial infection on the activity and longevity of *Chrysops*. The results are difficult to assess for the life of the flies is probably shortened by maintenance under laboratory conditions. Despite considerable damage done to the muscles of the fly by the mature larvae, there is no evidence of any lessening of the flies' activity. There are, however, indications that infected flies will take in more sugar solution than will uninfected flies, and that they will succumb more quickly to a shortage of sugar. There is also a slight but probably significant increase in the death rate of flies that have taken an infective blood-meal as compared with those fed on uninfective blood, and this fact may prove to be of considerable importance. The rate of development of *Loa* larvae in *Chrysops* maintained at different temperatures is also being investigated.

(ii) Studies on eggs, larvae and pupae of Chrysops:- The most important recent discovery has been that *Chrysops* will lay eggs on specially prepared stakes fixed in the mud at known breeding-sites. It should now be possible to elucidate many new facts, such as the range of possible breeding-sites, the importance of standing water, the attraction or otherwise of various types of ground - all of which will be of obvious importance when control of the fly is attempted. The stakes also provide a means of collecting naturally-deposited egg masses for laboratory studies on eggs and young larvae.

One large breeding-site, 100 feet by 50 feet, has been examined at regular intervals for two years for the purpose of recording the distribution of the various stages of larvae. The very young *Chrysops* larvae (up to five mm in length) are nearly always found in muddy water and as the eggs are usually laid on vegetation overhanging water, it is probable that the larvae drop into this environment on hatching. The older larvae (about 15 mm in length) are found distributed throughout the whole site, but tend to be in areas outside the water courses. Only a few pupae have been found, three in wet mud and one under a thin layer of water. It seems reasonable to suppose that the older larvae are more widely dispersed because they are more active and cannabalistic, and that they move to drier areas to pupate.

There is a large increase in the numbers of young larvae during the months of June and July, which corresponds to the increase in fly biting-activity (and presumably a corresponding increase in oviposition) in the period May to June. Later in the year there is a relative increase in the number of older larvae, presumably because of a falling off of oviposition during the heavy rains and the gradual maturing of the young larvae already in the breeding-site.

Studies on the identification of the larvae of different species of *Chrysops* have been intensified, for this knowledge is of obvious importance to the assessment of the results of larvicidal work. The pattern on the anal segment in the more mature larvae is of value in separating the *silacea* group from the *longicornis* and *griseicollis* groups, and a tentative key to the identification of species, embodying previous work on the differences in mandibles and antennae, is now available and will be tested during the coming year.

Two methods of differentiation of larval instars have been investigated, first by counting the numbers of corpuscles in the organ of Graber, and second by measuring the length of the mandible. In *Chrysops* there is no progressive increase, by stadia, in the number of corpuscles in Graber's organ although there may be such an increase in some species of *Tabanus*. The length of the larval mandible, however, increases at each moult by a fixed ratio and when the series of separate mandibular measurements for each instar of *silacea*, *dimidiata*, *langi* and *longicornis* has been completed it will be possible to say whether the mandible sizes for a given instar are sufficiently different in the various species to be of value in diagnostic work.

Insecticidal Studies: Work on insecticides has begun in earnest during the year, with field and laboratory investigations designed to find out which insecticide is the most efficient *Chrysops* larvicide when considered on a cost basis. Those under trial are DDT, BHC, dieldrin and aldrin all in the form of water emulsions, and dieldrin in colloidal granular form.

Field trials are being carried out in collaboration with the Colonial Pesticides Research Unit, Arusha, Tanganyika, to determine how long the various insecticides will persist under natural conditions in the muddy breeding-sites. The first series of breeding-sites was sprayed during the dry season and the analyses of mud samples collected within two hours of the application of insecticide show that there was a rapid movement of all emulsions down through the mud, and that a low concentration of insecticide reached a depth of six inches below the surface within two hours. There were higher concentrations of all insecticides in dry mud than in wet mud, but it is doubtful whether these differences are significant. Mud samples have been collected from the breeding-sites three months and six months after treatment but analyses of them have not yet been completed. More breeding-sites are about to be treated with insecticides during the rainy season and mud samples will be taken from them at similar intervals thereafter.

The field trials are being correlated with laboratory tests to determine the susceptibility of Chrysops larvae to different insecticides. The aim of these tests is to determine the concentration of emulsions of the insecticide that is required to kill 50 per cent of the larvae after immersion in the emulsion for ten minutes. Tests have so far been carried out with DDT, dieldrin and aldrin, and the results indicate that the larvae are about ten times more susceptible to dieldrin than to either DDT or aldrin at the same concentration. The toxicities of the latter pair are approximately equal, and BHC has yet to be investigated.

When these initial laboratory tests have been completed and when the analyses of more field mud samples are available, a new series of tests will be carried out exposing larvae, kept in deep trays full of mud, to lower concentrations of insecticides acting over longer periods.

Finally, anticipating the successful termination of these laboratory and field studies on insecticides, a detailed survey has been made of all the discoverable Chrysops breeding-sites within two miles of Kumba, with a view to an attempt at control of the fly at some time in the future; and, in order to assess the effects of any such control scheme, a long series of fly catches at various points on the perimeter of Kumba station clearing was started a year ago so as to provide base-line figures for the fly population before control is attempted.

Virus Research (Yellow Fever, etc.)

Entomological Research

(a) Field Studies at Ilobi Village:

(i) Catches of adult mosquitoes. - A two-year series of mosquito catches at the village at Ilobi was concluded in mid-June 1957. In the course of ninety-six 24-hour catches, over 26,000 mosquitoes were collected; of these, some 22,000 were Taeniorhynchus africanus and about 1,000 were A. aegypti. The A. aegypti found at Ilobi belongs to the type form of Mattingly and examination of adult mosquitoes, some bred from wild larvae and some from a colony established from wild Ilobi stock, showed more or less extensive pale scaling on the first abdominal tergite. The results of the catches indicate that at Ilobi the population of A. aegypti is exclusively 'domestic' in its habits and there is no 'semi-wild' element as is sometimes found among populations of A. aegypti sensu stricto.

(ii) The breeding places of A. aegypti. - Breeding of A. aegypti at Ilobi was restricted to the immediate vicinity of the village and within the village nearly all of the breeding took place in domestic clay pots. Examination of the number of pots in which A. aegypti pre-adults were breeding showed that approximately 55 per cent of breeding was in pots in fully exposed positions. Thus the species shows the regular 'domestic' pattern of breeding in that it is restricted to the immediate vicinity of the village, but this pattern is intensified by the fact that most breeding takes place inside houses. The importance of this behaviour with regard to disease transmission is apparent.

(iii) Field trials of insecticides against A. aegypti. A preliminary trial of ground fogging with dieldrin insecticide was carried out at Ilobi village. During the fogging process pots containing fourth instar larvae of A. aegypti were put out in the village in various situations and the larval mortality was recorded for each pot 24 hours after spraying. Some pots were placed inside the houses and others outside the houses in exposed and in sheltered positions. Larval mortality in all situations was 80-100 per cent, and adult mosquitoes in cages placed inside houses were all killed.

A trial of aerial spraying using DDT was much less successful. After the application of insecticide the larval mortality inside houses was only 1.5-2.0% per cent. Outside the houses larval mortalities of 23-100 per cent were recorded depending on the degree of exposure of the pot concerned. Aerial spraying had little effect on the natural population of A. aegypti and pot indices taken after the spraying indicated that the egg-laying population had not been reduced.

(b) Laboratory Studies at Yaba:

(i) Oviposition of A. aegypti: The various factors that influence the egg-laying behaviour of the adult female A. aegypti have been studied. From field observations it seemed possible that the size of the egg-laying site, the amount of organic matter in the water, the temperature of the water, and the light intensity above it might be among the factors determining the observed pattern of breeding, for the optimum egg-laying sites found in the village houses and away from the forest presented relatively large, exposed surface areas of water, free from decaying vegetable matter, in positions where water temperature and light intensity were low.

In the laboratory it was found that when gravid females were offered dishes of various sizes in which to lay their eggs, the number of eggs laid was in direct proportion to the surface area of the water in the dish. When a series of beakers was placed in a freely breeding colony and the water in the beakers was at various depths below the rims, the greatest number of eggs was laid in the beaker with the highest water level. When dishes of water containing different concentrations of dissolved vegetation were placed in a freely breeding colony of A. aegypti 70-80 per cent of the eggs were laid in the purest water and those dishes holding highly contaminated water were usually avoided as egg-laying sites. Other experiments showed that the insects oviposited preferentially in cool water and in dishes exposed to low light intensities.

(ii) Marking mosquitoes with radio-active tracer elements: Studies on the intake of radio-isotopes by mosquitoes have begun and it is intended to use these new techniques in order to mark adults for population studies. Preliminary experiments have shown that radio-phosphorus (P32) and radio-sulphur (S35) are easy to handle and are taken in abundantly by larvae from the water in which they are kept. Radio-cerium (Ce144), however, a powerful gamma emitter, is taken in in very small amounts and is not easy to use on account of the more stringent precautions that must be taken when handling an isotope with a 'hard' gamma radiation. Insects marked with radio-sulphur remained radio-active over longer periods than did those marked with radio-phosphorus. Most of the S35 was taken in during the second and third larval instars, but some radio-activity was lost during the fourth instar. Larval and pupal pelts exhibited only slight radio-activity. Eggs laid by radio-active female mosquitoes were also radio-active, and about half this activity was contained in the egg shell.

(iii) Experimental infection of A. aegypti with viruses: Work has continued on the infection of A. aegypti with Uganda S virus. Insects infected by feeding through mouse-skin membranes were titrated at intervals after infection and the subsequent curves of virus growth in head, thorax and abdomen were shown to be identical. It is not yet clear whether the virus is capable of multiplication in all tissues, or whether it is spread through the body by way of the haemolymph from a single site of multiplication.

The proportions of A. aegypti populations becoming infected after ingesting different doses of Uganda S and yellow fever viruses have been determined by experiment. Study of the data suggests that probit analysis of the curves obtained by plotting the virus dose against the percentage of mosquitoes infected might provide a mathematical basis for comparison of the efficiency of A. aegypti as a host for different viruses. More data are needed before the method can be evaluated.

(West African Council for Medical Research. Annual Report
1st July, 1957-30th June, 1958.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

CENTRAL AFRICAN REPUBLIC

Coffee: At the Boukoko Station, DDT, BHC, endrin and dieldrin were tested for the control of the West African coffee borer, *Bixadus sierricola*. Best results were obtained with 0.5% dieldrin emulsion painted on the trunk, 60 to 70 cm above the collar of the tree. Two treatments were made annually, one at end September to October, soon after mass emergence of adults, and the other during March and April.

("Plant Diseases and Pests in Some African Territories."
G. Bouriquet. FAO Plant Prot. Bull., Feb. 1959, 7, (5), 61-63.)

IVORY COAST

Cacao: Tests for the control of capsids and pod rots have been performed to determine the effectiveness of different pesticides. In the areas of Aboisso, Alepe, Grand Bassan and Dabou, control operations have been introduced by the extension services. During the heavy rainy season (April to August), diseased pods are collected, and the area is sprayed with 0.7% copper oxychloride plus a sticker every three weeks. During the light rainy season (August to September), spraying is done every 25 to 35 days, according to the abundance of rainfall.

("Plant Diseases and Pests in Some African Territories."
G. Bouriquet. FAO Plant Prot. Bull., Feb. 1959, 7, (5), 61-63.)

PROPRIETARY DATA

AGROSAN GN
Plant Protection Ltd.

Organo-mercurial dry seed dressing with good sticking properties, reputed to kill seed-borne fungal spores on contact and to reduce seedling blights caused by soil-borne organisms. It is formulated with a "special volatile constituent" designed to penetrate the glumes (chaff) of oats to kill fungal spores underneath. Standard rates of application are: 4 oz./cwt. (wheat, barley, rye or maize); 5½ oz./cwt. (oats, jute and rice); up to 16 oz./cwt. for cotton.

ALDERSTAN AND DILSTAN.
The Standardised Disinfectants Co. Ltd.
23, Sloane Street, London, S.W.1.

Alderstan EC-30.

An emulsifiable concentrate containing 30% w/v aldrin i.e. 3 lb. aldrin per Imperial gallon. When added to water mixes immediately and gives a stable emulsion. It is claimed to be especially useful for control of soil pests where its ability to give off insecticidal vapour is of great advantage.

It is recommended for control of wireworms in potatoes, cereals, sugar-beet, carrots and other drilled crops, tomatoes, lettuces, strawberries and other transplanted crops, and for the control of chafer grubs and mole crickets at 6-8 pints in 10 or more gallons of water before planting. For the control of leather jackets and cutworms, a spray of 4 pints in 25-100 gallons of water/acre or a bait prepared by mixing ½ pint with 25 lb. bran and broadcast at 25-40 lb./acre is recommended. Alderstan may also be used for the control of ants and the cabbage root fly.

Dilstan EC-15

An emulsifiable concentrate containing 15% w/v dieldrin, i.e. 1½ lb. dieldrin per Imperial gallon. It is non-volatile and very persistent.

It is recommended for the control of carrot fly at 2½ pints in 50-100 gallons of water/acre and mangold fly at 2 pints in 10-30 gallons of water/acre. Other recommendations are made for the control of clover, lucerne, pea and bean weevils, and the mustard, blossom or pollen, and flea beetles.

ARMOUR HESS CHEMICALS LTD.

The Chemical Division of Armour Chemical Industries Limited and Hess Products Limited have been merged under the name of Armour Hess Chemicals Limited, of which half the share capital is controlled by Armour and Company of Chicago, whilst the other half is controlled by United Kingdom interests, including a substantial proportion by Associated Chemical Companies Limited.

BRUNOBAIT
The Standardised Disinfectants Co. Ltd., 23, Sloane Street, London, S.W.1.

A pelleted formulation of a bait containing metaldehyde for the destruction of snails and slugs. It is claimed to be more resistant to rain and watering than conventional forms of metaldehyde slug baits. For broadcast applications 25-28 lb. Brunobait per acre is recommended.

No information is given regarding the amount of active ingredient.

COOPER PEGLER & CO. LTD.
Burgess Hill, Sussex.

Leaflets on two new pieces of equipment have been received with the 1959 catalogue of spraying and dusting machinery from this firm.

The 'FALCON'

A lightweight (11 lb. empty) pneumatic sprayer recommended by the manufacturer for the spraying of insecticides etc. but not suitable for sulphuric acid, Bordeaux mixture and copper-based fungicides. It has a working capacity of 2 gallons, the liquid being poured into the galvanised container through a 5 in. funnel opening. It is fitted with a plastic hose, a brass spray lance with trigger control and a conical spray nozzle. Working pressure is 80 lb. p.s.i. Two models, either with single strap, or with 2 straps and back rest are available.

The 'HURRICANE'

A knapsack power mist blower and duster designed for low volume spraying with high concentrations of insecticides and fungicides. A petrol engine is directly coupled to a fan which has a speed of up to 5,500 r.p.m. The fan speed can be caried by the operator during spraying if a lower velocity of air is required and output is controlled by means of a finger-tip valve on the lance between 1/10 and 1/2 of a gallon per minute. (Powder 0-4½ lb. per min.) The machine is equipped with a brass conical nozzle giving direct emission, but also includes a deflector nozzle which fits over the standard nozzle to direct the fine mist spray in any direction required for "up under" or "down onto" etc. spraying. A double row crop nozzle is also available.

Vibration is claimed to be completely eliminated by a foam rubber back pad and rubber block mountings between the engine/fan unit and the carrying frame. Conversion to a powder duster by replacing the spray tank with a powder container complete with air agitator and delivery tube with output control takes about two minutes. The machine is supplied with or without a recoil starter.

Technical Data

Weight	37 lb.
Working capacity	2¼ gal. liquid - 20 lb. powder.
Engine	SACHS 2-stroke 1¾ h.p. petrol.
Petrol tank	3½ pints petrol/oil mixture (sufficient for approximately 3 hours running).
Liquid tank	Special hard plastic resistant to heat and chemicals.
Powder container	Light weight metal alloy.
Lance	15¾ in. metal lance with rubber handle grip attached to a 19 in. reinforced air hose.
Nozzle	Brass nozzle producing a conical mist spray; also deflector nozzle for engle spraying.

DORMAN "LINDINGER"

The Dorman Sprayer Co. Ltd., Ditton Walk, Cambridge.

An orchard mist sprayer developed for low volume spraying in Denmark and now manufactured under licence in this country. It may be tractor mounted in 2-3 minutes.

The tank of 50 gallons capacity is fitted with a paddle type agitator driven from the power take-off shaft. The fan (volume 5,600 cu.ft./min, speed 11,000 ft./min) casing has four outlets and the casing is divided into two sections, one half may be rotated enabling two nozzles to spray on each side of the machine. Each nozzle is independently adjustable. Standard nozzles give application rates of 10-50 gal./ac. on trees of 36 ft. planting. Other nozzles are available for application rates of 2½ gal./ac. Where non-abrasive materials are being sprayed the machine is supplied with a gear type pump suitable for pressures up to 150 p.s.i. For abrasive material such as Bordeaux mixture or lime sulphur, a double acting piston pump (350 p.s.i.) is fitted.

Further details are available from the manufacturer.

THE DOW CHEMICAL COMPANY

Down to Earth, Spring 1959, 14, (4), contains the following articles:

"Cockroach Control with Korlan 24 E in Mississippi".
W.O. Miller and J.K. Webb, pp. 9-10.

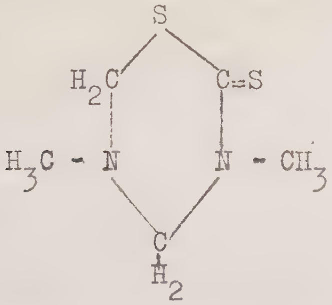
"Korlan for Control of the Hornfly".
K.L. Hays. pp. 15-16.

FYTOLEX
Bayer Agriculture Ltd.

Dual purpose, brassica seed dressings, containing gamma BHC (for the prevention of flea beetle attack from sowing to the first rough leaf stage) and captan, (to safeguard the emergence of healthy seedlings). Treatment rates vary from ¼ to 1 oz. per lb. of seed depending upon the severity of flea beetle attack. Treated seed may be stored safely for several months at or below the ½ oz. rate. The dressing is also indicated for use on carrot seed generally at 2/3 oz. per lb. of seed and will prevent attack for 4-5 months in early crops and for 2-3 months if late sown.

MYLONE 85 W SOIL FUMIGANT
Union Carbide

Soil fumigant containing 3,5-dimethyl-tetrahydro-1,3,5,2H thiadiazine-2-thione, (Mylone), formulated as 85% wettable powder.



Active material is a white crystalline solid melting at 99.5°C. It is soluble in trichloroethane, ethylene dichloride and acetone; only slightly soluble in water. The single oral dose LD50 of this material to rats is 0.5 g/kg body wt. Tests indicate that Mylone is not readily absorbed through the skin and is not a primary skin irritant. It will kill most growing plants at recommended dosages and therefore should not be allowed within four feet of growing plants or closer than the drip line of trees or large shrubs. Until adequate residue studies are completed crops grown in treated soil must not be used for food or feed.

The product is reported to control various annual and perennial weeds, nematodes, soil fungi and soil insects.

Weed Control

Mylone 85 W has been tested in the U.S.A. as a herbicide for the past three years, Considerable evidence has accumulated that, at 300 lb./acre it will control such annual weeds as: crabgrass, *Digitaria sanguinalis*; henbit, *Lamium amplexicaule*; pigweed, *Chenopodium* sp.; foxtail, *Setaria* sp.; purslane, *Portulaca oleracea*; lambs quarters, *Chenopodium album*; chickweed, *Stellaria* sp.; carpetweed, *Mollugo verticillata*; peppergrass, *Lepidium* sp.; mustard, *Brassica sp.*; coffee weed, *Sesbania exaltata*, and the following perennial weeds: bindweed, *Convolvus* sp.; Bermuda grass, *Cynodon* dactylon; Johnson grass, *Sorgum halepense*; wild artichoke, *Stachys floridana*, nutgrass, *Cyperus* sp.

(Control of nutgrass has not been complete in all instances. Improved performance can be obtained by repeated cultivation and irrigation prior to treatment.)

Nematocidal Effect

Laboratory tests indicate that control of nematodes can be secured at rates less than those required for weed control. In greenhouse pot tests a dosage equivalent to 90 lb./acre was completely effective against the root knot eelworm (*Meloidogyne incognita*). Applied as a surface drench on tobacco seed beds in a sandy loam soil, weeds and root knot nematode have been effectively controlled at 2 lb./100 sq. ft. Additional tests have indicated that Mylone is active against the following species: Southern root knot nematode, *Meloidogyne incognita*; cotton root knot nematode, *Meloidogyne incognita* acrita; meadow nematode, *Pratylenchus pratensis*; citrus nematode, *Tylenchulus semipenetrans*; pin nematode, *Paratylenchus minutus*; kidney-shaped or reniform nematode, *Rotylenchulus reniformis*; Javanese root knot nematode, *Meloidogyne javanica*; stubby root nematode, *Trichodorus* sp. It will not, however control encysted nematodes (*Heterodera* spp.) at the recommended dosages.

Fungicidal Activity

Mylone has given excellent control of *Pythium* spp. in greenhouse pot tests at the equivalent of 150 lb. per acre 6 inch furrow slice, and has been successfully used in field plots (e.g. equivalent to 50 lb./acre) for the control of damping-off of peppers and tomatoes. In other field tests Mylone has controlled *Fusarium*, *Pythium*, *Phytophthora*, *Stromatinia*, *Rhizoctonia* and *Verticillium* spp. affecting a variety of crops.

As a Soil Insecticide

In laboratory tests Mylone has given high mortality of house fly larvae (*Musca domestica*) and Southern armyworm larvae (*Prodenia eridania*). In these tests Mylone was incorporated in rearing media or soil and it provided kills at levels comparable to those normally used for DDT and chlordane. In a field test conducted at Phelps, New York, against European chafer (*Amphimallon majalis*), the material gave excellent control at 300 lb./acre, and showed promise as a grass toxicant.

Application

Mylone should be applied before planting. The soil must be kept moist for five to seven days before treatment. The bed should be well tilled and free of clods. If perennial weed control is desired, several cultivations are advised. Wait at least three weeks after treatment to plant. Under cool soil conditions (60°F or lower at two-inch level), a longer waiting period may be necessary. Fall treatments are recommended if early planting is necessary. The entire bed should be well ditched to prevent untreated soil and weed seeds from washing into the treated area.

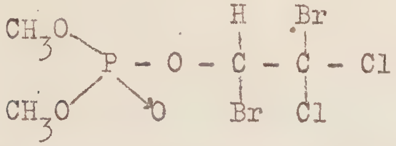
The recommended dosage is 300 lb. per acre of Mylone 85 W (¾ lb./100 sq. ft.) evenly over the soil surface. This may be conveniently applied as a surface drench, agitating the spray and applying at the rate of 6.75 lb. Mylone 85 W in 150 gallons water per 100 sq.yd. Other methods of dissemination are by fertilizer spreader, sprayer or by furrowing.

THE MURPHY CHEMICAL COMPANY LIMITED has issued the following literature:

Murphy Pest and Disease Chart, 1959.
Diazitol Atomizing Concentrate (leaflet).
Observations on Apple Mildew and Red Spider with Recommendations for Control (pp.6). Jan. 1959.
Murphy Products for Aerial Spraying (Leaflet) Mar. 1954. 6 pp.
Murphy Fruit Growers' Booklet 1959. (pp. 110).
Revised recommendations for the use of this firm's products in the U.K.

ORTHO DIBROM (RE 4355)

California Spray-Chemical Corporation.



Field trials are in progress in the U.S.A. with emulsifiable concentrate and 4% dust formulations of the new insecticidal chemical 0,0-Dimethyl-0-(1,2-dibromo-2,2-dichloroethyl) phosphate, ("Dibrom").

The technical material, which has a slightly pungent odour, is liquid at room temperature. It is moderately volatile and boils at 110°C (0.5 mm). It is insoluble in water, slightly soluble in aliphatic solvents and highly soluble in aromatics. The compound is stable under anhydrous conditions but is decomposed by alkali, and hydrolyses in water (90-100%) in 48 hours. Dust formulations are storable for one season.

The material has been tested against Drosophila, mosquitoes, Colorado potato beetles, fleabeetles, grasshoppers, springtails, chicken lice and mites, cabbage worms, Japanese beetle, housefly, European red mite, 2-spotted mite, leaf miners, various aphids, leafhoppers, and many foliage feeding larvae. It is rated chiefly as a contact and stomach poison but possesses some vapour effect. Its residual activity is relatively short.

The optimum effective dosage for many insect pests has not been established. Effective control of the insects on which tests have been conducted have indicated that a dosage of ½ to 1 pint emul.conc. (8 lb. active per gal.) per 100 gal. water and 40 to 50 lb. per acre of the 4% dust would be indicated as preliminary dosages. It is suggested that higher and lower dosages be tried experimentally.

The material has been used on a large number of tree fruits, small fruits, field crops, vegetables and ornamentals with generally good plant safety. Phytotoxicity has been noted on apples and pears from application in the early cover sprays, on cotton in the South but not in Western areas of the U.S.A., on hegari, scarlet runner beans and on occasional ornamentals. Condition leading to injury and means to overcome it are under study.

Toxicology

The acute oral LD_{50} on rats is 430 mg/kg; the acute dermal LD_{50} on rats is 1,100 mg/kg. In sub-acute feeding studies, 30 p.p.m. in the diet of rats fed 27 days showed no histologic, anatomic, or toxic effects. Dibrom is therefore considerably less toxic than most organic phosphate insecticides and slightly less taxic than DDT. The standard organo phosporus spraying precautions are nevertheless indicated when handling this substance. Atropine is antidotal.

It is suggested that Dibrom be tried as an insecticide or miticide in conditions likely to respond favourably to a contact or short-residual insecticide.

Adequate quantities are available for field trial and special formulations if required, on request to:

California Spray-Chemical Corporation,
Research Laboratories,
Lucas and Ortho Way,
Richmond, California, U.S.A.

(Patents applied for.)

THE "OSPREY ACE"

The Dorman Sprayer Co. Ltd., Ditton Walk, Cambridge.

A knapsack machine which can be used for mist spraying, dusting or mist dusting. It is powered by a 75 c.c. two-stroke engine using 25:1 petrol/oil mixture and developing 3b.h.p.: the blower produces an air velocity of up to 390 ft./sec. The engine and blower are cast from a light alloy and wherever possible, e.g. tanks and hopper, flexible plastics are used; most liquid pipes are transparent. An upholstered back pad is fitted, and air gaps between the back plate and the blower and engine insulate the operator from heat.

For dusting an airstream provides agitation of the powder, which becomes airborne in the hopper and is sucked in the delivery tube of the nozzle. The volume of air entering the dust hopper can be controlled and sufficient volume is available to enable granulated insecticides to be handled.

For mist dusting a 1½ gallon liquid tank can be used to replace the hopper lid and water from this is fed to the nozzle at a rate of approx. 2 gal./ac.

For liquid spraying the tank is pressurised to ensure uniform flow from the nozzle and output is adjustable from 0.4 to 3.5 pints/minute. Droplet size is said to be very uniform, ranging from 50-150 µ

Weights,	empty, for dusting	33 lb.
	" " mist dusting	35 lb.
Capacities.	Spray tank	2.25 gal.
	Dust hopper	9 lb.
	Mist dusting water tank	1.5 gal.
	Fuel tank	3 pints.

Further details are available from the manufacturer.

PLANT PROTECTION LTD.

The following booklet has been received.

Aerial Sprays. (8 pp.)

"PLYAC", SPREADER-STICKER.

Agricultural Technical Service, Allied Chemical Corporation,
General Chemical Division, 40, Rector Street, New York, 6, N.Y.

An adjuvant containing non-ionic surfactants. The principal functioning agents are emulsifiable A-C Polyethylene 629 (a wax-like polymer with approx. M. Wt. 2000, M.P. 213-221°F) and emulsifying and dispersing agents.

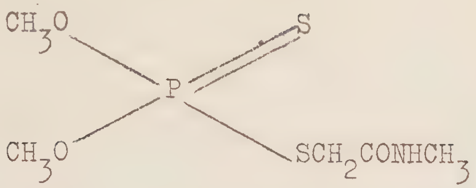
Plyac films, applied at normal rates, are claimed: not to affect plant transpiration; to be resistant to water; to improve the coverage of pesticides on fruit and foliage; to make deposits more resistant to weathering, and to increase the effectiveness of certain pesticides.

It is stated that Plyac has been found to be very effective in sticking on heavy deposits of materials, such as insecticides for borer control in tree trunks, where a heavy persistent deposit is desired for long protection. It has also been found very effective as a sticker for pesticides used in seed treatment. This material is especially suggested for trial and use with wettable powder pesticides which normally leave deposits that are more subject to loss by action of rain than are deposits of emulsifiable formulations.

Further details are available from the manufacturer.

ROGOR 40

Fisons Pest Control Ltd.



Light brown yellowish liquid of pungent odour containing 40% w/w O,O-dimethyl-S (N-methyl carbamoyl methyl) phosphorothiolothionate, with solvent and wetting agent. It is stable for normal periods of storage and soluble in water at 20oC to the extent of 6%. Flash point (closed cup) 107°F; crystallising point -10° to -12°C.

The active ingredient ranges in appearance from white crystalline solid (pure) to yellowish semi-solid (technical). It is of low volatility, m.p. 48-49°C; solubilities (w/v) at room temperature are as follows: water (2.5%), olive oil (1.5%), carbon tetrachloride (1.0%), benzene (6.5%), chloroform (80%), methanol (30%). The compound (neutral) is hydrolysed by aqueous alkali ($K = 6.91$ min^{-1} moles $^{-1}$ at 25°C) and slowly by water ($K = 10 \times 10^{-3}$ min $^{-1}$ at 80°C, pH 6.9). It becomes gradually acidic through slow decomposition on storing. Little data on its compatibility with other pesticides is as yet available; applications with copper or sulphur formulations should be made within 1 to 2 hours.

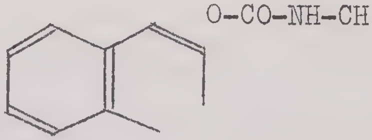
The compound, predominantly an indirect inhibitor of cholinesterase, is of comparatively low mammalian toxicity. Acute oral LD_{50}, single doses mg/kg are: male rat, 300; guinea pig, 600; rabbit, 400; duck, 80; pheasant, 15; hen, 35. Acute dermal LD_{50} single doses are (for the formulated technical material), male rat, 750; mouse, 200; guinea pig, $>$1,500. It is partially cumulative in toxic effects. Experiments with rats and guinea pigs show that cholinesterase depression is the most sensitive index of over-dosage, but is not caused by doses of 0.8 mg/kg or less. In man, 18 mg daily (equivalent to 6 kg food at 3 p.p.m. residues) caused no cholinesterase depression in a twenty-one day period.

Recommendations are tabulated for the use of the formulated material, based on the results of trials carried out in the U.K. and elsewhere (1956-58).

The product acts as a contact/systemic and should, for maximum rate of absorption and "knockdown", be applied in a fine spray - not to the point of "run off". The effect persists for two weeks. When used on food crops, 14 days should elapse before harvesting hops, brussels sprouts or sugar beet, and 21 days for strawberries. The half life on crops ranges from 2 to 5 days. Analysis of residues is by a method described by Chilwell, E.D. (Fisons Pest Control) based on one for schradan.

Crop	Pest	Time	Dosage	Remarks
Hops	Aphids	Late May to mid-June	16 fl.oz. in 100 gal. of water	100-150 gal. of spray per acre for the first application
	"	3 weeks after 1st spray	16 fl. oz. in 100 gal. of water	200-250 gal. of spray per acre for the second application
Sugar Beet	Black aphis (blackfly)	Immediately winged aphids appear on the crop	16 fl. oz. in 25-100 gal. per acre	A second application may be needed after 2 weeks if re-infestation occurs
Brussels Sprouts	Cabbage aphis	As soon as aphids appear on the plant	20 fl. oz. in 25-100 gal. per acre	It is preferable to spray at as high a volume as possible, to ensure a good coverage A second spray may be necessary 2 weeks after the first, if re-infestation occurs
Strawberries (a) Fruiting Beds	Strawberry aphis Shallot aphis	Late April to early May, just before flowering and before the aphids build up in the crop	16 fl. oz. in 25-100 gal. per acre	A second application should be made immediately all the fruit has been picked
(b) Runner Beds and Maidens	"	1st Application mid-May, 2nd Application at the end of June	16 fl. oz. in 25-100 gal. per acre	

SEVIN - EXPERIMENTAL INSECTICIDE
Union Carbide Ltd. U.K. Distributors, Murphy Chemical Co. Ltd.,
Wheathampstead, St. Albans, Herts.



N-methyl-1-naththyl carbamate.

Physical Properties:

The technical material is a slightly coloured, nearly odourless, crystalline solid, .. white in the highly purified state. Its melting point is 142°C, vapour pressure is less than 0.005 mm, Hg at 26°C and density is 1.232 at 20/20°C. Solubility ranges to 40% in organic solvents; is less than 0.1% in water.

Stability:

Under normal conditions is stable to hydrolysis, light, heat and prolonged storage.

Compatibility:

Compatible with most other insecticides and fungicides.

Phytotoxicity:

Laboratory tests at normal and high rates of wettable powder and dust formulations have not produced injurious symptoms on important crop plants. There is some indication that excessive dosages will retard or reduce seed germination and stand, particularly of grass crops. Where slight leaf burn has occurred, it is believed due to the solvents used in experimental emulsifiable and granular formulations, and steps to correct this have been made.

Toxicology:

Acute oral LD_{50} to rats is 500-700 mg/kg, rabbit skin penetration LD_{50} is in excess of 2,000 mg/kg. While chronic studies are not complete, a low degree of chronicity is indicated to date. This information and similar findings on various formulations indicate that this is an insecticide of relatively low mammalian toxicity hazard.

Formulation:

Formulations which have given satisfactory field performance include a 50% wettable powder, 25% emulsifiable concentrate, 5% dust and 5% granular. An emulsifiable concentrate for low gallonage sprays, containing one pound of Sevin per gallon, has also been developed.

Uses:

From laboratory and field tests the most important use, so far, would appear to be for the control of DDT resistant codling moth against which ½-2 lb. 50% W.P. per 100 U.S. gal. has given excellent control. Other suggested uses are for other fruit pests, and pests of cotton and vegetables.

THE STANDARDISED DISINFECTANTS COMPANY LTD.

This Company has issued a Technical Information Sheet No. 6/6 entitled: "Report on Anti-mosquito Spray Trials carried out with Crop Culture (Aerial) Ltd., Bembridge, Isle-of-Wight.

Three formulations of DDT supplied by SDC were used in this trial.

THURICIDE

Stauffer Chemical Company, Agricultural Research Laboratory,
P.O. Box 757, Mountain View, California.

This is an experimental microbial insecticide composed of viable spores of *Bacillus thuringiensis* Berliner. It is formulated as a wettable powder and as a dust from active material produced by Bioferm Corporation, Wasco, California.

Thuricide is claimed; to be specific for certain insect pests and does not affect bees, insect parasites and predators; and to be harmless to man, other warm blooded animals, fish and plants, and creates no residue problem. There is also reasonable assurance that susceptible insects will not develop resistance. Thuricide has been given temporary exemption from a tolerance by the Food and Drug Administration for application to a wide group of food and forage crops. The U.S. Department of Agriculture has granted an experimental permit for shipment and field scale testing. Requirements for an effective dose are that the insecticide must be applied to plant foliage in such a way that viable spores will be ingested by the insect that is to be controlled, and a concentration of insecticide must be applied so that the minimum insect ingestion rate is 450 viable spores/mg insect body weight.

Tentative dosage levels are ½ - 3 lb./ac. wettable powder and 5 - 30 lb./ac. dust formulation.

Samples and additional information are available from the manufacturer.

WOODTREAT TC

Wood Treating Chemicals Co., 5 137 Southwest Avenue, St. Louis 10, Mo.

Woodtreat TC is a bodied oil-in-water emulsion closely resembling "mayonnaise dressing" in consistency and colour. It is composed of 87% by weight of solvents and carriers containing 10% pentachlorophenol (78.3% solvents and carriers and 8.7% PCP on total weight), and 13% water and emulsion stabilizers. The product is a semi-stable, highly viscous, self-sustaining emulsion that can be applied to wood surfaces in thicknesses up to one inch or more. The ingredients are claimed to impart good protection to wood against termites and decay. Soon after the application is made to wood, the PCP in oil starts to penetrate the wood, the water begins to evaporate, and a thin film is formed over the outside of the treatment that protects it until all but the emulsion stabilizers are dissipated into the wood. When this is accomplished, only a thin film remains on the wood, and it ultimately dries up.

Woodtreat is spread up to ½" thick by brushes, paddles, scoops or by specially designed applicating equipment.

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W. R. Allen. Canada Dept.Agric., Res.Branch Publication 943. Rev. Apr. 1959, pp.2

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2) effects of different dosages of DDT with and without mineral oil,
3) effects of timing and number of applications of DDT - mineral oil sprays,
4) influence of intervals between applications of DDT sprays.

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A. L. Wharton. W.African J.Biological Chemistry, 1958, 1, (4), 111-7.

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I. - DESCRIPTION OF THE DISEASE AND ITS SPREAD IN THE NURSERY.
S. R. Chant Tropical Agriculture, Trin. 1959, 36, (2), 138-144.

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O. A. Hills and E. A. Taylor. U.S.Dept.Agric.Leaflet No. 389. Rev. Mar. 1959, pp.8.

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CITRUS INDUSTRY OF ARGENTINA.
J. H. Burke. U.S.Dept.Agric., Foreign Agric.Service, Foreign Agric. Report No. 114. Jan. 1959, pp.79.

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Reprinted from Coffee and Tea Industries, 1958, 81, (11).

Contains 19 articles including: Recent Spraying for Control of Coffee Diseases" by F. L. Wellman and "Biological Control of Insect Pests in Coffee" by A. R. Melville.

INDIA COFFEE BOARD, RESEARCH DEPARTMENT, has issued the following leaflets from COFFEE RESEARCH STATION, BALEHONNUR, Sept. 1958.

No. 1.	Nursery Practices in Coffee Includes control measures.		
No. 2.	Nursery Practices in Coffee (2) Includes control measures.		
No. 4.	Planting Practices in Coffee Includes control measures.		
No. 10.	Pests of Coffee and their Control	(1)	The Coffee Stem Borer (*Xylotrechus quadripes* Chev.)
No. 11.	"	(2)	The Green Bug (*Lecanium viride* G)
No. 12.	"	(3)	The Shot-Hole Borer (*Xyleborus morstatti* Hgdn.)
No. 13.	"	(4)	The Eelworms - (Nematodes)
No. 14.	"	(5)	Minor Pests.
No. 15.	Diseases of Coffee and their Control.	(1)	Leaf Disease (*Hemileia vastatrix* B & Br.)
No. 16.	"	(2)	Black-Rot (*Pellicularia koleroga* Cke., *Corticium koleroga* Cke., V.Hohn.)
No. 17.	"	(3)	Die-back.
No. 18.	"	(4)	Nursery Diseases.
No. 19,	"	(5)	Minor Diseases.

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A. M. Toms. Empire Cotton Growing Review, 1959, 36, (1), 5-11.

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J. H. Stapley. Commercial Grower, 1 May 1959, p.1071.

THE MANGO IN INDIA.
S. R. Gandhi. Indian Council of Agricultural Research, New Delhi, Farm Bulletin No. 6.
Rev. Sept. 1957. pp.64.

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THE NARCISSUS BULB FLY: HOW TO PREVENT ITS DAMAGE IN HOME GARDEN.
C. F. Doucette. U.S. Dept.Agric. Leaflet No. 444. Mar. 1959, pp.8.

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W. F. Turner and H. N. Pollard. U.S.Dept.Agric., Tech.Bull. No. 1193. Feb. 1959, pp.27.

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PINK DISEASE OF HEVEA CAUSED BY CORTICUM SALMONICOLOR BERK. ET BR.
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Control measures are given.

BARK ROT AND CANKER OF HEVEA: PHYTOPHTHORA PALMIVORA.
Rubber Res.Inst.of Ceylon, Advisory Circular No. 64. Dec. 1958, pp.3.

'Antimucin', an organo-mercury preparation was found to be outstandingly effective and is currently recommended at 1 fl.oz. in 1-2 gal. water.

'Kankerdood' - a paint-like mercury-based preparation is recommended as a waterproof fungicide.

THE PHYTOPHTHORA LEAF DISEASE OF HEVEA: PHYTOPHTHORA PALMIVORA.
Rubber Res.Inst.of Ceylon, Advisory Circular No. 65. Dec. 1958, pp.4.

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T. M. Greensill. Eastern Region of Nigeria, Dept.Agric.Tech.Bull.No. 2. pp.55.

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P. Whiteley. Paint Manf., 1959, 29, (3), 87; (4), 125.

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J. B. M. van Dinther. Proc.10th Intern.Cong.Entomology, 3, 329. Abs. only.

5% BHC dust, 25% BHC W.P., copper sulphate, 20% colloidal copper paste.

PROCEEDINGS OF THE TENTH INTERNATIONAL CONGRESS OF ENTOMOLOGY, MONTREAL, AUGUST 17-25, 1956.
Ottawa, Canada, Dec. 1958.

Contains 686 papers arranged in the following sections:
Volume 1. - Introductions, Systematics, Morphology and Anatomy, Geographical Distribution, Palaentology, Arachnida and other Land Arthropods (pp.1041).
Volume 2. - Physiology and Toxicology, Behaviour, including Social Insects, Ecology, Genetics, Cytology and Biometrics. (pp.1055).
Volume 3. - Agricultural Entomology, Medical and Veterinary Entomology, (pp.895).
Volume 4. - Stored Products Entomology, Forest Entomology, Biological Control, Agriculture (pp.1115).

REPORT OF A CONFERENCE OF DIRECTORS AND SENIOR OFFICERS OF OVERSEAS DEPARTMENTS OF AGRICULTURE AND AGRICULTURAL INSTITUTIONS HELD AT WYE COLLEGE, KENT, SEPTEMBER 1958.
London, Colonial Office Miscellaneous No. 531. 1958. pp.169.

The major subjects discussed were land use, consolidation and farm planning; soil fertility; extension methods; the mechanization of tropical agriculture and the training of agricultural staff. Summaries of two special lectures delivered during the conference are are given in an appendix:

(i) Recent Development in Herbicides and Fungicides. R. L. Wain.
(ii) Isotopes in Agriculture. H. J. M. Bowen.

THE BRITISH SOCIETY FOR THE PROMOTION OF VEGETABLE RESEARCH: 9th ANNUAL REPORT, 1958.
National Vegetable Research Station, Wellesbourne, Warwick. 1959. pp.55.

Contains an entomology report by D. W. Wright, pp.31-5, dealing with:
The Natural Control of Cabbage Root Fly at Wellesbourne. (R. D. Hughes, D. D. Salter and B. Mitchell).
The Control of Carrot Fly. (D. W. Wright).
Carrot Fly on Parsnips. (G. A. Wheatley and J. A. Hardman).
Lettuce Root Aphid. (J. A. Dunn).
Pea Moth (J. A. Dunn and G. A. Whatley).
Bioassay of Insecticide Residues in Soil and Plant Tissue. (G. A. Wheatley and J. A. Hardman).

YEAR BOOK OF THE PLANTER'S ASSOCIATION OF CEYLON FOR THE YEAR ENDED APRIL, 1958, pp.64.

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE. REPORT OF THE GOVERNING BODY AND THE PRINCIPAL'S REPORT FOR 1957-58.
St. Augustine, Trinidad, 1959. pp.64.

ANNUAL REPORT OF THE FOREST INSECT AND DISEASE SURVEY, 1958.
Canada Dept.Agric., Forest Biology Div., Science Service pp.114.

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NORTHERN NIGERIA, NYASALAND, WEST INDIES.
Empire Cotton Growing Corporation, London 1959.

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ABSTRACTS

IMPERIAL COLLEGE, ANNUAL REPORT APRIL 1959

Mode of Action of Insecticides

Uptake of Oil

It was previously shown that oil picked up by the tarsi quickly spreads as a film over the rest of the body (See PANS (A), 1958, 4, (3), 373). Improved techniques have allowed the diffusion of the oil using iodised hexadecene as a tracer in mineral oil (R.17) to be followed in greater detail.

The oil, advancing over the cuticle at first as a monolayer, is simultaneously being absorbed; but the rate of diffusion over the cuticle exceeds the rate of diffusion into the cuticle. For example the steady rate of flow onto the wings averages 1×10^{-8} ml. per minute while the rate of absorption into the wings averages 3×10^{-9} ml. per minute. At this rate of flow a monolayer is established over the wings in from 5 to 15 minutes. The measurements are made on individual flies and it is found that the degree of activity during the exposure time substantially affects not only the quantity accumulated by the tarsi but also the rates of diffusion of the oil on the cuticle. These effects are apparently correlated with the depression of spines on impaction of the tarsi and the movement of accumulated oil past constrictions of the cuticle surface, e.g. leg joints.

Other experiments have shown that after absorption into the tissues the radioactive iodine is split off the hydrocarbon tracer molecules. The tracer thus ceases to be useful after absorption and cannot be employed as a guide to internal movements of the oil.

Biochemical Investigations

The comparative biochemical investigation into the effect of chlorinated hydrocarbon insecticides on the esterases, cholinesterases, and the lipases of insect nerve tissue has been continued. (See PANS (A), 1958, 4, (3), 374).

Estimations of activity using the Warburg technique showed an apparent increase in esterase activity upon the addition of pp'DDT (0.65 mg/ml. - 1.3 mg/ml.), dieldrin and BHC (0.15 - 0.3 mg/ml.) to locust Schistocerca gregaria brain tissue and acetylcholine chloride. It was decided to check these findings using a more accurate pH titrometric method. Very many estimations have been carried out using several insecticides at various concentrations. In all cases the addition of insecticide to a mixture of locust brain tissue plus acetylcholine chloride caused an increase in esterase activity which was not due to dehydrochlorination, but was dependent upon the final concentration of the insecticide and the nature of the insecticide.

The relationship between percentage increase in activity and concentration is not linear but appears to show a maximum which differs for each insecticide. It was then decided to determine whether this effect occurred in blowfly Phormia terraenovae brain tissue. It was found that dieldrin, at a final concentration of 400 µg/ml. causes a slight inhibition (10-20%) of acetylcholinesterase activity.

It should be pointed out that neither method of estimation distinguishes between esterase and lipase activity since both measure the production of acid. It was also found that in homogenised brain tissue of this fly there is no endogenous esterase or lipase activity due either to the absence of esterase or lipase enzymes or of their substrate or both. This result differs markedly from that obtained with locust brain tissue which has an endogenous esterase or lipase activity, increased upon the addition of chlorinated hydrocarbon insecticides but not to the extent to which the acetylcholinesterase activity is increased. It has been shown by dialysis that the acetylcholinesterase of blowfly brain is dependent for its activity upon the presence of magnesium ions; however the addition of this ion does not promote endogenous esterase or lipase activity.

In order to determine whether there is any connection between resistance and these effects on esterase and lipase activity two cultures of houseflies have been established; one is susceptible to dieldrin and the other resistant to it at a level of 150 p.p.m. in the larval diet. Preliminary results have not shown any significant differences between the two strains in the effect of dieldrin on the acetylcholinesterase activity, but in view of the results obtained with locust brain tissue the effects on other esterases and lipases will be investigated.

A sample of tritiated pp'DDT of specific activity approximately 135 microcuries per gramme has been prepared by exposing pure DDT to 4 curies of Tritium gas at Harwell. The material has been checked for radiochemical purity by a combination of partition chromatography and autoradiography, with satisfactory results. The preparation will be used for the quantitative estimation of DDT in the finer structures of poisoned insects.

Chemical Senses of Blood-sucking Flies

The study of the responses of Stomoxys calcitrans to olfactory stimulation by straight chain fatty acids and related compounds has been continued. The results indicate that the most promising fatty acids for use as attractants in the field are those having 12-18 carbon atoms per molecule, for two reasons: (1) having low vapour pressures samples should persist well after application to a surface; (2) they are attractive at the saturated vapour pressure as well as at lower concentrations; thus an attracted fly will tend to remain at the source for some time. In contrast, lower fatty acids are more fugitive and are repellent to flies at the higher concentrations which obtain near a source.

These conclusions are based on two series of experiments. In the first series the distributions of groups of flies were recorded at minute intervals for 30 minutes in the olfactometer described in a previous report, in which the flies were presented with a choice between pure air and air containing known concentrations of stimulant. High concentrations of fatty acids with 12 to 18 carbon atoms were found to be attractive while longer or shorter chain acids were repellent at high concentration. However, results showed that the flies disturbed each other to an extent which reduced the sensitivity of the response to any stimulus. It was therefore decided to trace all details of the movements of solitary flies presented, in a simpler apparatus, with a choice between atmospheres saturated with stimulant and relatively free of stimulant.

The chamber consisted of a circular glass dish of which half the bottom was covered with charcoal, and the other half a layer of fatty acid on filter paper. About 0.5 cm above the surface of the charcoal and the acid a fly was retained in a gauze disc. The dish was then closed with a transparent air-tight lid. The atmosphere above the acid became saturated with its vapour, whilst over the charcoal the vapour was absorbed. The flies were allowed to walk over the surface of the disc, and their path was followed and plotted. Without an olfactory stimulus the fly spent equal times on both halves of the dish. Acids which induced the fly to spend more than 50% of the time over the stimulus were said to be attractive, and less than 50% were said to be repellent.

Behaviour of Solitary Flies in Choice Chamber

	No. of Carbon Atoms in Fatty Acid Molecule								
	6	7	9	12	14	16	18	20	22
Percentage of Time over Stimulus	10	18	37	56	68	64	64	50	32
Frequency of Stopping (Stops/sec x 10^3)	0	0	14	7.8	4.5	5.5	9	3.6	3.3
Length of Pause (in sec)	0	0	21	40	60	34	24	22	4
Frequency of Turning (Turns/cm)	0.083	0.16	0.17	0.20	0.25	0.25	0.53	0.40	0.26

When percentage of time spent over stimulus is plotted against chain length, a curve is obtained with a maximum of myristic acid (C_{14}). Acids below C_{12} and above C_{18} were not attractive at saturated vapour pressures. Myristic acid also gave a maximum effect for duration of pauses over the stimulus. The maximum frequency of turning was obtained with stearic acid (C18). The maximum frequency of stopping was obtained with nonylic acid (C9), the frequency declining not quite regularly as the chain length increased. In acids more volatile than nonylic, the flies did not stop.

A limited series of experiments on the part played by the sense of taste in inducing probing by Stomoxys was started. The tarsal organs are similar in appearance to those of blowflies but a positive probing response is obtained to a wider range of compounds.

UNIVERSITY OF BRISTOL - LONG ASHTON RESEARCH STATION ANNUAL REPORT 1958-1959. (C.D. & W. Scheme No. R.737)

Spraying Techniques

Sampling Techniques and Determination of Spray Residues

The methods of sampling spray residues on plant tissues received from the Colonial Territories, reported as under investigation last year, (see PANS (A), 1958, 4, (3), 393) have been extensively tested. In some cases such as the spray deposits of DDT on coconut spadices, extraction must be carried out on the spot and the extracts sent in specially prepared glassware to the U.K. Several satisfactory techniques, types of apparatus and methods of transit have been perfected. These methods have been tested out for DDT, copper and mercury fungicides residues on coconut, coffee, tobacco, abaca hemp and banana.

Mercury Residues on *Arabica* Coffee

At the request of the Coffee Berry Research Unit, Kenya, mercury spray residues were determined at various stages of growth of the crop. It was shown that mercury residues occur in the infused, roasted and ground coffee. (1)

DDT and the Control of *Pseudotheraptus* and *Amblypelta* on Coconuts.

A considerable number of DDT determinations have been made on material received from Kenya and the British Solomon Islands. It has been shown that, regardless of formulation, the DDT spray is rapidly absorbed on the spadix. The chemical assays have been correlated with biological data. It would appear from the data relating to the Solomons that the bugs are killed by direct contact with the spray at the time of application or immediately after. The residual action of the DDT seems of limited importance in view of its rapid absorption by the plant tissues. Laboratory and field trials are still in progress in Kenya.

Frog Eye of Cigar Wrapping Tobacco.

The control of frog eye on tobacco in North Borneo is none too satisfactory despite an extensive spray programme. Preliminary observations suggested that the technique of spraying was faulty. It was found with the normal method of spraying the level of copper fungicides on the vulnerable under-surface of the leaves was rarely above 0.05 micrograms of Cu per sq.cm, a very low figure for a copper deposit applied at a concentration of 0.1%. Further, it was found that 42% of the target area was unsprayed. Experiments on the cigar wrapping tobacco grown at Long Ashton showed that, using the same fungicides as in Borneo, the normal deposit of Cu was 1 to 5 micrograms per sq.cm. It was also suspected that the concentration of the wetter Ethylan C.P. might be critical; however, it was found that a concentration in excess of that required for wetting did not reduce the level of the copper deposit. It was concluded that the present methods of hydraulic spraying by means of lances, however carefully carried out, were unsatisfactory in that the coverage was inadequate and too much mechanical damage was caused to the crop.

Preliminary experiments, using a sledge design of mist-blower, are being conducted on tobacco grown at Long Ashton.

Spray Physics and Machinery

Flying Spot Particle Resolver

A flying spot particle resolver has been installed for studies on droplet sizes and emulsions. The equipment records automatically the number and sizes of droplets and particles, and will make a major contribution to the work on mist-blower spraying techniques.

Mist Blower Sprayers

The outstanding problem in the design of mist-blower sprayers is an effective, simple and reliable method of atomising a large fluid throughput of 3-5 gallons per minute into droplets of the order of 80-100 microns size. Two methods of atomisation have been investigated by designing atomisers based on known data on the shear of liquids by air. One nozzle operates on compressed air at sonic speeds, and the second on air at a velocity of 300 m.p.h. These nozzles have been incorporated in the design of two tractor-operated mist-blower sprayers.

(a) A Compressed Air, Twin Fluid Mist Blower

A twin-fluid, compressed air nozzle, described by Cobbald in the 1957 Long Ashton Annual Report, has been developed further. With a liquid throughput of 26 fl.oz. per minute and an air pressure of 80 lb./sq.in. (air/liquid mass ratio of 0.84), it gave a spray of 55 microns mass median diameter. Mean droplet size increases almost linearly with liquid throughput, and at 1½ gallons per minute the spray was 340 M.M.D.

Eight of these nozzles were assembled on a manifold assembly, which was fed with spray from a gear pump at low pressure and with compressed air from a high duty rotavane compressor. These components were mounted as an integral unit on the three points suspension tool system of a Ferguson 65 tractor. The assembly formed a compact and relatively simple mist blower, which may be particularly useful for spraying the undersides of foliage of bush plantation crops. The machine is undergoing field evaluation.

(b) A Prototype Low Pressure, Twin Fluid Atomiser

A multi-vane nozzle (2) was designed in the form of specially shaped leaves, mounted in a spiral within a wide air tube. Each leaf is flooded with a controlled flow of liquid at low pressure, which is atomised into small droplets by a flow of 200 cu.ft. of air at 250-300 m.p.h. velocity. This design of atomiser is simple and shows considerable promise, and it has been mounted on a tractor-drawn machine for field evaluation.

Pneumatic Shoulder-type Sprayer

A demand arose in North Borneo for a simple, cheap, pneumatic sprayer for applying insecticides to bananas, cocoa and coffee. Ten spray machines fitted with the Long Ashton $\frac{1}{4}$" B.S.P. nozzles, lances and trigger taps have been tested by peasant labour, with satisfactory results. The liquid container consists of welded steel sheet, lacquered inside to reduce corrosion. It is not recommended for use with copper fungicides.

Lightweight Power Sprayers

Eight machines were made at Long Ashton and supplied to Kenya, North Borneo and St. Helena for experimental work. The machines were modified according to local requirements.

References

(1) Martin, J.T and Pickard, J.A. "Spray application problems. Mercury residues on coffee leaves and berries in relation to the control of berry disease." Ann.Rep.Long Ashton Res.Sta. 1958. (in the press).

(2) Cobbald, T.E. "Spray application problem. A prototype low pressure twin fluid atomiser." Ann.Rep.Long Ashton Res.Sta. 1958. (in the press).

COLONIAL PESTICIDES RESEARCH UNIT, PORTON
ANNUAL REPORT 1958-59

CPRU/Porton/Report No. 162.

Residual Properties of Organo-Phosphorus Insecticides

Previous reports: PANS, 1958, 4, (3), 379; Ibid. 1959, 5, (1), 108.

Results obtained against *A.aegypti* on plywood panels are summarised: "Diazinon and chlorthion are highly toxic to *A.aegypti* initially, but whereas diazinon loses its effectiveness after 2-4 weeks as it is lost by evaporation, chlorthion retains its toxicity for at least 2 months. Malathion is also persistent, but is less effective than chlorthion. It is intended to test the most promising of the organo-phosphorus insecticides against mosquitoes resistant to chlorinated hydrocarbons."

Further reference is made to the decomposition process on dried mud surfaces with respect to several organo-phosphorus compounds: "At a temperature of 25°C on a Uganda soil humidity did influence the rate of decomposition but quantitatively the effect varied from one insecticide to another. This is shown in the accompanying table where the figures are the half-life in days at an insecticide concentration of 0.1%.

Insecticide	Relative Humidity 20%	Relative Humidity 80%
Diazinon	7.6	0.9
Chlorthion	2.1	2.5
Iso-chlorthion	0.9	0.8
Parathion	4.3	2.6
Malathion	c.13	5.9

Thus whereas the rates generally increase with humidity, as would be expected if the water available for hydrolysis was a limiting factor, chlorthion actually decomposes more rapidly at the lower humidity. It is probable that the reactions are complicated ones depending upon the nature of the soil surface and the presence of metal ions with catalytic properties as well as on temperature, humidity and concentration. The form of the detailed kinetics is variable although generally there is a straight line relationship between percentage decomposition and the logarithm of time up to about 80% decomposition.

A wide range of activity is shown amongst different soils in catalysing the decomposition and there is as yet no clue as to the soil properties or components which are involved."

Breeding of Agricultural Insects

"The heavy incidence of virus disease has rather limited the numbers of larvae available from the culture of *Pieris brassicae* which is being maintained. Improvements are being made in the cages to try and prevent this common difficulty with *Pieris* cultures.

Attention is still being given to the methods of breeding the African maize stalk borers, *Busseola fusca* and *Chilo zonellus*."

Pick-up of Deposits by Caterpillars

"The relative amounts of a particular deposit picked up by late instar larvae of *Pieris brassicae* have been determined by counts of fluorescent areas on photographs of the underside of a larva taken under ultra-violet light after walking over a deposit of a fluorescent dye, salicyl aldazine. As an example, the following relative amounts of deposit are found on different segments:

Head-1%; Thorax 1-3%, II - 4%; III - 6%, Abdomen I - 3%
II - 6%, III - 12%, IV - 12%, V - 13%, VI - 18%,
VII - 8%, VIII - 4%, IX/X - 10%.

The amounts adhering to the segments bearing appendages seem to be related to the degree of contact and probably also to the pressure exerted by the appendage.

The standard methods of anaesthesia tend to induce the ejection of a repellent liquid, the reflex defence mechanism of the caterpillar. As this liquid complicates any estimation of the amount of deposit adhering to the head, alternative methods of anaesthesia are being examined."

Seed Dressings

Following work in East Africa on control of the bean fly, Melanagromyza phaseoli, with seed dressings (see CPRU/Porton/Report No. 158), attempts are being made to follow the distribution of seed dressings on beans. Using a fluorescent dye as a tracer, very little material appears to contaminate the soil surface or to remain on the stem."

Control of Maize Stalk Borer, Busseola fusca

Refer to page 415 of this issue.

Application of Pesticides from Aircraft.

"A number of functioning trials have been carried out to ascertain the aircraft speed and height at which the spray produced by the S.A.6 apparatus might be effective for penetrating foliage. Deposits on both faces of vertical and horizontal sampling cards were recorded when the helicopter was operated at various speeds and heights. The details and information obtained from these trials have been described in CPRU/Porton/Report No. 159).

A digest of the literature relating to the use of rotary wing aircraft for the dispersion of pesticides has been prepared. The aspects covered include air flow characteristics of rotary wing aircraft, the type and performance of the dispersion equipment employed and a comparison of rotary wing aircraft with fixed wing aircraft and with ground equipment. The report has been issued as Porton Technical Paper 668."

Other Topics

No further developments are reported for the following topics which are listed with previous reference: Contamination of materials by insecticide vapours (PANS, 1959, 5, (1), 108); sampling insecticide deposits on mud surfaces (Ibid, p.108); standard emulsion concentrate (Ibid, p.109); dispersion of molluscicides (Ibid.p.110).

COLONIAL PESTICIDES RESEARCH UNIT, ARUSHA, TANGANYIKA ANNUAL REPORT 1958-9.

INSECTICIDES

Tsetse - Field Trials

Loljoro Experimental Area

Introduction of Pupae

This work was reported in C.P.R.U. Misc.Report No. 212 and summarised in PANS (A), 1959, 5, (1), pp.126-7.

Experiments with Aircraft

See PANS (A), 1959, 5, (1), p.127 for summary of C.P.R.U. Misc.Report No. 213.

Chungai

See preliminary report in PANS, 1959, 5, (1), p.111.

Applications of insecticide to the isolated tsetse block which commenced in July 1958, ended in early January 1959. The Auster J5G aircraft, fitted with two Britten-Norman rotary cage sprayers, was used to apply a 5% (w/v) solution of γ BHC at a nominal dosage of 0.08 gal./ac. The swathe width was 70 yd., and there were seven applications, at approx. 28 day intervals.

There appeared to be no significant immigration into the sprayed area across the mile-wide barrier clearing separating the area from the other half of the original 25 square mile block.

The apparent density of G.morsitans fell in both experimental and control areas before the start of spraying operations, the two values being similar. Following the first application the A.D. fell considerably in the sprayed area, and the second application reduced it to about one tenth of the value in the control area. During September and October, however, a large number of teneral flies appeared, and the A.D. rose sharply in both experimental and control areas. Generally, from the lowest point, after the second application in August, the population slowly increased despite temporary reductions, until November, after which a slow decrease was observed. This seasonal pattern of rise and fall was paralleled, at a higher level, in the control population. The final apparent density in the sprayed block in January, 1959, was comparable with that after the first application in July. During February and March, 1959, a sharp rise occurred as is usual at that period, but the value in March was only about half that of the previous year, and half that of the control area to which, before treatment, it was roughly equal.

The population density of G.pallidipes also fell before spraying commenced. The apparent density of this species also exhibited temporary decreases after each application of insecticide, but catches were too small to assign confidently any significance to individual fluctuations. Nevertheless, the A.D. in March, 1959, was only about a third of that in March, 1958.

The kills of G.morsitans old males per application based on catches immediately before, and immediately after, each application showed that the first two applications were the most successful. Owing to the low numbers caught, it is difficult to estimate accurately the kill of old females per application, but there is evidence that they succumbed to a lesser degree than the males, and this is supported by the fact that during the seven months prior to spraying, the old females constituted 4.6% of the total catch, old males forming 89.6%, but during the period July, 1958, to January, 1959, the old females constituted 11.7% of the catch with the figure for old males dropping to 70.7%. By March, 1959, the figures had returned to 6.5% for old females and 85.3% for old males.

The low kills could have been due to a number of reasons. Firstly, too great a reduction in the volume dosage. Secondly, the relatively unstable meteorological conditions, particularly after the first two applications. The successful preliminary trials at Loljoro were carried out under very stable meteorological conditions, and the one performed in November under less stable conditions suggested a greatly reduced kill of females. In view of the low kills of males in some of the later applications, it would seem possible that the kills of females on these occasions could have been negligible. Thirdly, that the spraying equipment did not function consistently over the relatively long periods involved in a complete application, and that consequently the drop spectrum deviated from that planned. In particular, observable mechanical trouble was experienced during the third application, when the kill of old males was only 43%. Finally the September-November period is one of natural annual increase in this population. If the females survived the early applications and laid pupae, this would account for the great preponderance (up to 43% of the total catch) of young flies which were observed during August-November, the emergence of which largely swamped the effects of the insecticide.

Kabiganda

This work was described fully in C.P.R.U.Misc.Report No. 218 and summarised in PANS (A), 1959, 5, (2), pp.225-7.

The Effect of Repeated Insecticidal Application on a Natural Tsetse Population

Misc.Report No. 207 (see PANS (A), 1959, 5, (1), p.126) gives full details.

Tsetse - Laboratory Work

Laboratory Colony of *G.morsitans*

An account of this work from C.P.R.U. Misc.Report No. 214 appears in PANS (A), 1959, 5, (1), pp.128-9.

Susceptibility of Tsetse Flies to Insecticides

In order to be able to investigate any suggestions of resistance of tsetse flies to insecticides, attempts are being made to develop a routine test for susceptibility, using the W.H.O. adult mosquito test kit as a basis. Experiments are being carried out with *G.palpalis* in the laboratory, and with *G.morsitans*, *G.swynnertoni* and *G.pallidipes* in the field.

MOSQUITOES - FIELD TRIALS

Taveta-Pare Scheme

See PANS (A), 1959, 5, (1), pp.111.

The 6th and last cycle was completed in March 1959, and the human population has now been protected for three years. It is still difficult to assess the origin and significance of the low degree of parasitaemia still present in man. There are still a very few infant infections which appear to have been acquired in the treated area, but the parasite rates of all ages continue to fall and the rate of fall has accelerated recently. Assays in the eradication by drugs of parasite infections are now being made in certain localities in an effort to assess the amount of transmission taking place.

The reduction of A.gambiae in treated houses is at least 90 per cent in all areas, but the overall reduction in the A.gambiae population is much less than this. It is possibly to one third of pre-treatment figures in Taveta and the South Pare main road villages but the overall reduction in the South Pare swamp villages where most of the A.gambiae feed on cattle is negligible. Typical A.funestus has virtually disappeared although a few larvae of the type form have been found. There is still no evidence of any resistance of A.gambiae to dieldrin nor of change in host choice or its behaviour generally. Culicine mosquitoes, fleas, bed bugs and lice in the area do however show varying degrees of resistance to dieldrin.

Mto wa Mbu

See PANS (A), 1959, 5, (1) pp.111-2.

In this village which was sprayed in September 1957 with a dieldrin resin wettable powder, house collection of Anopheles during the 1959 mosquito season rose almost to the level recorded in the 1956-7 season.

SMALL SCALE AND LABORATORY TRIALS

Hut experiments - Magugu

There are now twenty experimental huts and a field laboratory alongside the village of Magugu 90 miles south west of Arusha. The huts are built of brick and can be plastered with any required type of mud mixture, or lined with materials such as plywood to investigate the behaviour of insecticides on such surfaces.

During the past year experiments have been carried out in these huts in cooperation with Shell Research Ltd. and Plant Protection Ltd.

The experiments carried out in conjunction with Dr. N. van Tiel of Shell Chemicals Ltd. were chiefly to obtain information on the possible reasons for the discrepancies found between laboratory and field results on the relative performance of dieldrin and dieldrin/resin wettable powders.

Two series of experiments were carried out, one series was sprayed at the end of March 1958, and the other at the beginning of June. In each case standard dieldrin W.P. and various dieldrin resin formulations were sprayed at a dosage of approximately 0.20 grams dieldrin/sq. metre on to the sorptive mud interior surface of experimental huts in which Africans slept. For comparison one hut with non-sorptive mud was sprayed with standard dieldrin W.P. and one left unsprayed as a control. Entomological evaluation was made by daily assessments of the 24 hour mortality amongst female mosquitoes entering the huts, by means of window exit traps, and daily searching of the floor for dead mosquitoes, and by wall exposure tests. Records were also taken of rainfall, temperature and relative humidity.

The overall mortalities showed little difference between the formulations but from wall tests there were indications that, as time went on and the season became dryer, the most effective of the formulations (EF 814) was rather more effective than the standard dieldrin wettable powder.

Laboratory tests with mud blocks also showed very little difference in effectiveness between the formulations except that EF 814 was considerably more effective than the other formulations except when the blocks were stored in humid conditions when standard dieldrin W.P. was the most effective. Tests during the dry season on a mud wall in the laboratory confirmed the greater effectiveness of EF 814.

To sum up it may be said that the best of the dieldrin/resin formulations are more effective than the standard dieldrin W.P. on sorbent mud in dry conditions but that the overall difference in the kill of mosquitoes produced in the field is very slight.

The experiments carried out in conjunction with Plant Protection Ltd. were to compare the behaviour of standard BHC wettable powder with BHC/resin formulations. Here the emphasis was rather different from that of the previous experiments because sorption into mud probably extends the period of effectiveness of the volatile BHC and resin is included in the formulations to reduce volatility. Two series of experiments were carried out. In the first series, sprayed in April 1958, huts plastered with a non-sorptive mud were sprayed with each of the two formulations at approximately 0.25 and 0.5 grams of γ BHC per square metre, and huts plastered with a sorptive mud were sprayed with each formulation at approximately 0.5 grams of γ BHC per square metre. In the second series, sprayed in November 1958, two huts were plastered with sorptive mud, two with non-sorptive mud and two lined with plywood. One of each pair was sprayed with standard BHC wettable powder and the other with BHC/resin wettable powder; all at approximately 0.5 grams of γ BHC per square metre.

Results were based on the overall mortality of female anopheline mosquitoes entering the huts, that die on the floor or are caught in exit-traps supplemented during the dry season when numbers were low by wall exposure tests with laboratory bred mosquitoes.

The overall mortalities have shown little difference so far between the formulations on any surface but differences are expected to show up when the mosquito numbers increase during the coming rainy season. Wall tests, on the first series of huts, have shown the resin formulations to be much more effective than the standard wettable powder 10-12 months after application and there is some indication from the second series that the difference is noticeable on non-sorptive mud after 2 or 3 months.

Hut experiments - Muheza

It has been found during the hut experiments at Taveta and Magugu that it is not possible to account for all the mosquitoes that enter the experimental huts, and that the design of these huts could be improved.

Experiments have now been started with the cooperation of the East African Malaria Institute, to determine, among other things, the optimum size, shape, and position, of entry slits and exit traps, in experimental huts. At present a single adaptable hut is being used but later a series of huts will be built.

This work is being carried out at Muheza, 25 miles inland from Tanga, where there is a plentiful supply of *Anopheles gambiae* and *A.funestus* throughout the year.

Susceptibility - A.gambiae

Surveys have shown that; there is considerable variation in the susceptibilities of *A.gambiae*; *A.gambiae* from all places investigated are more susceptible to dieldrin than the colony mosquitoes; and from nowhere are they appreciably more resistant to the other insecticides.

Susceptibility - Aedes aegypti

The effect of temperature during the exposure period on the median lethal concentration of dieldrin to *Aedes aegypti* has been further investigated. The MLC's vary from 0.8 per cent at an exposure temperature of 18-19°C. to 0.07 per cent at a temperature of 26°C. Under the conditions of these experiments, variations in the post-treatment appear to have no effect on the MLC.

A.aegypti adults under 24 hours old are being exposed in successive generations to dieldrin treated papers to see whether a dieldrin resistant strain can be produced.

W.H.O. Test kit

Two types of exposure chamber, one a cone, and the other a dish chamber with a slide to permit the insects to be isolated from the test surface have been assessed.

The tests were carried out on a prepared mud surface as the wall surface of the average native house is so uneven that this type of exposure chamber cannot be used. Not more than fifteen mosquitoes at a time could be exposed in the conical chamber because otherwise mutual excitation of the mosquitoes during removal increased unduly the exposure time.

There was no difference in the results obtained with the two types of exposure chamber, and the results so obtained were considered to be fully interchangeable. During the tests, A.gambiae and A.aegypti were exposed to sorptive and non-sorptive muds treated with both DDT and dieldrin. The wall tests were accurate enough to show the effect of sorptive and non-sorptive muds on the two insecticides, and the variation in these effects with changing humidity.

(Full details are given in Misc.Rep. No. 222.)

Susceptibility of Cimex hemipterus

Six months after the treatment of the experimental huts at Magugu with dieldrin, bedbugs were reported in most of the huts and they increased rapidly in numbers. The susceptibility of these bedbugs to dieldrin compared with that of bedbugs from untreated houses in a village two miles away from Magugu was measured by the standard W.H.O. kit for adult mosquitoes. Mixed populations from each area were exposed for two hours to treated papers and the mortality twenty-four hours later recorded. 1.6% dieldrin gave a kill of 100% for bedbugs collected from untreated houses and only 26% from Magugu.

PSEUDOTHERAPTHUS

Tanga - Experiment 1 (See PANS (A), 1959, 5, (1), p. 112.)

It is considered too early (only 6 months protected yield so far) to make any real estimate of the relationship between P.wayi damage and yield of coconuts. From observations on two sets of spadices (fruiting branches), however, which were studied from flowering to harvest, it would appear, from the information so far obtained, that during the rains more female flowers are formed and set than in the dry season but, since the palms appear to shed an approximately constant proportion of the flowers formed, the total numbers of young vidaka shed are also higher. This gives rise to the apparently anomalous relationship that, the higher the total shedding in a given period, or on a given plot, the larger the yield twelve months later. During the rains, although numbers of P.wayi may be higher, their proportionate effect upon yield is less than in the dry season, because so many female flowers are formed, that, even after P.wayi has caused many to shed, the remaining vidaka are still more than the tree can carry. Conversely, during the dry season, when few female flowers are being formed, lesser losses due to P.wayi will have a proportionately greater effect upon yield. It should be noted, however, that although the proportionate increase in yield, due to Pseudotheraptus control, is less during the rains, when flowering is heavy, the difference in actual numbers of nuts, harvested from sprayed palms and unsprayed palms, is greater.

Tanga - Experiment 2 (See PANS (A), 1959, 5, (1), p.113.)

Aerial spraying consisting of a double application, with a 14 day interval, of 1 lb. DDT in one gallon of spray is carried out every 3 months. Each double application of insecticide has resulted in a great reduction in damage. However, although the damage drops to a minimum on the sprayed plots 5 or 6 weeks after the application it then rises again and just before the succeeding application has, in some cases, almost reached the level of the controls again. Since spraying has only been in progress for one year it has not yet had any effect upon yield.

Tanga - General

There are very clear indications that clean cultivation under the palms will result in considerable increase in yield. It is hoped, therefore, to start a further trial to study the combined effects of Pseudotheraptus control and various methods of coconut cultivation.

Zanzibar - Aircraft Trial (See PANS (A), 1959, (4), 3, pp.388-9).

The results of this trial to compare three different insecticide treatments using the Auster JG5 have now been analysed. The numbers of punctures counted on vidaka collected on each cleared plot each week for the 4th to 8th weeks after the spray application were expressed as a fraction of the mean number of punctures per week counted on the same plots for the four weeks prior to spraying:

BHC aerosol using Britten-Norman gear. Double application of 1/8 lb. BHC in $\frac{1}{4}$ gallon of spray/acre at 14 day intervals.	0.33
Single application of 1 lb. DDT in 2 gallons/acre using spray boom	0.37
Single application of $\frac{1}{4}$ lb. dieldrin in 2 gallons/acre using spray boom.	0.61
Untreated control.	1.22

All three treatments reduced the numbers of feeding punctures being made and were significantly different from the controls (P. 0.001 d.f. = 1). The BHC aerosol and the DDT residual spray were not significantly different from each other but both were significantly better than the dieldrin residual spray. (P.0.01 d.f. = 1).

It is now apparent that all insecticides were used at too low a dosage and a further aerial spraying trial is to be carried out in May, 1959. In this trial a double application of 0.25 gallons aerosol, containing 0.25 lb. γ BHC, per acre will be compared with a single application of DDT at 2 lb./acre in 2 gallons applied as a coarse spray.

Zanzibar - Laboratory Work

A laboratory colony of P.wayi has been built up. Freshly cut vidaka are supplied and all stages feed readily on freshly peeled vidaka. The life history of a strepsipteran parasite of the adult bug is being investigated.

Records are being kept of the weather conditions during routine catches and the type and condition of the palms climbed. It is hoped to find some correlation with the numbers of P.wayi caught, which during January and February, 1959, averaged 0.34 bugs per palm. Records to date bear out previous conclusions that palms housing the ant Oecophylla are unlikely to contain P.wayi nymphs, and it was found that a surprising number of palms in an area, in which the antagonistic ant Anoplolepis custodiens was established, supported Oecophylla colonies.

OTHER AGRICULTURAL PESTS

Cotton

Screening of acaricides against the Tetranychus telarius complex was reported in Misc.Rep. No. 219 (see PANS (A), 1959, 5, (2) p.222-5).

The Unit is assisting the Red Bollworm Research Unit at Gatooma, Southern Rhodesia, by making a detailed physical and mechanical study of various methods of applying insecticides to cotton.

It has been found useful to use table tennis balls as artificial cotton bolls for attachment to plants as a suitable framework for the assessment of dosages in the field.

Coffee

Dosage distribution upon Coffee leaves

Some experiments have been carried out to determine the deposits upon coffee plants treated with the Fisons - Pest-Control "Pestmaster", and air-blast sprayer. Representative plots of coffee were chosen, and sprayed by driving the machine between all the rows. Dyed water was applied in a spray with a mass median diameter of 300-350 microns. The fourth or fifth leaves along branches were collected from various sites for both multiple - and single-stem coffee; the deposits on upper and lower surfaces were swabbed off and estimated colorimetrically. On multiple stem coffee, except for the lowest levels, the average dosages on upper and lower leaf surfaces were not very different, but there was a pronounced drop in dosage with height above the ground. On single stem coffee, except for the outermost parts nearest to the sprayer, the dosages on the under surfaces of the leaves was about half these on the upper surfaces.

Droplet size distribution from hollow-cone nozzles

Hollow-cone nozzles, known as "Disc-Type Teejet Nozzles" and manufactured by Spraying Systems Co., Chicago, U.S.A., are being used for hand spraying in coffee, and some measurements have been made of the droplet-size distributions produced under typical operating pressures. Dyed water was sprayed, and the droplets were collected in a vaseline-paraffin mixture and sized microscopically. The main results are summarised in the table while fuller details are given in C.P.R.U. Miscellaneous Report No. 206.

The Mass Median Diameters of the Droplet Distributions

Produced from Some Hollow-Cone Nozzles

Nozzle	Operating Pressure (p.s.i.)	Mass Median Diameter (microns)
D2 - 13	20	305
D2 - 13	50	215
D3 - 23	20	340
D3 - 23	50	230
D4 - 45	20	605
D4 - 45	50	375

Persistence of diazinon on coffee

Diazinon emulsifiable concentrate was applied to coffee trees by a Pestmaster sprayer at the rate of 1 lb. active ingredient in 100 gallons per acre. Deposits from shaded and unshaded plots were estimated immediately, and one and three days after spraying. The amounts of diazinon were determined chemically by the method of total phosphorus and the results are given in the following table.

Deposits of Diazinon

(Milligrammes per square metre of leaf surface)

Days after spraying	0	1	3
Shaded Plot	19.5	3.0	1.1
Unshaded Plot	9.9	2.2	0.9

After 24 hours the deposit in the shaded plot had fallen to 15 per cent of its original value, while that in the unshaded plot had fallen to 22 per cent. After three days the values were 6 per cent and 9 per cent respectively. The difference in level of the initial deposits is noteworthy, the deposit in the shaded plot being twice as great as that in the unshaded plot. This may probably be attributed to loss of spray before deposition.

The data collected were insufficient to yield a regression equation for loss of diazinon with time, and the trial will therefore be repeated with increased frequency of sampling.

Coffee Berry moth

Work has commenced on the coffee berry moth, *Thliptoceras octoguttalis,* in cooperation with the Coffee Research Station, Lyamungu. At present breeding techniques are being developed in preparation for bioassy work with different insecticides.

LOCUSTS

Aircraft applications of insecticides against settled locusts

Swarms of the desert locust, *Schistocerca gregaria Forsk*, sometimes present a special sort of target in that the locusts often settle densely in small trees rather than on the ground. These locusts are likely to pick up more insecticide than ones settled on the ground, particularly if the insecticide is applied in small droplets and there is a strong wind. As a guide to experimental work some calculations have been made of dosage distributions under various field conditions, and for several droplet-size distributions. The aircraft was considered to be effectively a point source moving at right angles to the wind; atmospheric turbulence and attenuation of the spray were ignored, and it was assumed that droplets fell along trajectories determined solely by their terminal velocities and the wind speed. For calculating pickup upon locusts it was assumed that they were equivalent to cylinders 1 cm in diameter and 5 cm in length, oriented at right angles to the wind.

Results show that for the cylinders the swathe width is effectively greater than for deposits upon the horizontal ground surface, and that this is particularly true for strong winds and small droplets. Experimental work is being carried out to investigate this aspect of aircraft spraying.

Aircraft Applications of insecticides to control the African Migratory Locust in the Central Niger Delta.

Experiments could only be carried out against parent solitaries as no hopper bands were present. It was concluded that approximately 1 gallon of an oil solution of BHC (12% w/v γ BHC) per acre produced a kill of adults of at least 98 per cent; with 0.5 gallons per acre the kill was 95 per cent. An attempt to kill adult solitaries by means of "lattice" spraying was unsuccessful. Applying dieldrin as a 2.5 per cent w/v oil-in-water emulsion at approximately 1 gallon per acre, along runs forming rectangular grids with spacings of 100 yd. and 200 yd. between runs, high kills were achieved where the insecticide deposited, but the populations within the grid elements were not sensibly affected.

It was concluded that the parent solitaries do not move sufficiently for such a technique of application to be successful.

Only tentative conclusions could be made upon the effectiveness of aircraft methods in destroying hopper bands and preventing plague formation. It is suggested that the present ground methods probably do not give a certain insurance against outbreaks, particularly because in the future it will be difficult if not impossible to obtain the necessary and large labour forces. The adoption of aircraft techniques might prove to be highly effective, on the other hand, but this must be tested under a variety of field conditions.

BITING FLY RESEARCH IN UGANDA

Laboratory Work

The laboratory colony of S.calcitrans has been maintained at a controlled level of approx. 3,000 flies throughout the year. An account of the life history of S.calcitrans has been prepared for publication.

Field Work

Routine hand catching from the five herds of cattle at Bukomero has continued. In addition to this, Morris fly traps have been constructed and are in use in each of the five cattle bomas. It is considered that the use of these fly traps reveals a more accurate and consistent representation of fly densities.

The density of adult Stomoxys over an area of approx. 50 square miles was reduced by 99% after the application of insecticide to a cattle boma - the only recognised breeding site in the locality.

FUNGICIDES

Persistence of a copper fungicide on coffee leaves

Copper oxychloride wettable powder was applied to single stem coffee by a Pestmaster sprayer at the rate of 2.5 lb. copper in 100 gallons per acre. Paired leaf samples from a standard site in the tree were taken soon after spraying. Further samples were taken at various intervals of time after treatment in order to study the rate of loss of the deposit. The duplicate samples afforded (i) the mean deposit on the whole surface of the leaf, and (ii) the upper and under surface deposits separately. The initial levels of deposit on the upper and under surfaces of the leaves were approximately equal and their mean value corresponded closely with the mean overall value

(62 milligrammes of copper per square metre of leaf surface, on the first application). The plot has been re-sprayed at two-monthly intervals, and the persistence figures recorded after the second application (November to January, rainfall: 6 inches) have been analysed statistically. Three regression equations, each of the form:

$$x = a - b \log_{10} (t + 1)$$

where x = copper residue in mg/square metre of leaf surface,
t = time after spraying in days,
a = initial deposit of copper,
and b = regression coefficient,

have been obtained for the rates of loss of copper from the whole-leaf surface, the upper surface and the under surface, separately.

Constants of the Regression equations for loss of copper

	a	b
Overall deposit	102	36
Upper surface deposit	105	46
Under surface deposit	96	26

The values of the initial deposit, a, given in the above table, are similar; the regression coefficients for upper and under surface deposits, however, are significantly different. They indicate a much greater rate of loss of deposit from the upper surface of the leaves in the climatic conditions of the trial. The mean value of these two regression coefficients (b = 36.2) is in very good agreement with that derived from the mean duplicate sample which yielded the overall deposit (b = 36.0). There is no evidence to show that copper deposited on the upper surface is transferred to the under surface by weathering.

In the months immediately preceding the long rains the value of frequent applications of copper has become apparent in the improved leaf retention and the complete absence of Hemileia, the leaf rust of coffee.

Estimations are to be made of copper accumulating in the leaf tissue.

Electrostatic dusting of coffee trees in East Africa

(See CPRU Misc.Rep. 227.)

The performance of a dusting machine equipped with an electrostatic charging device has been assessed in a number of field trials. The duster was operated in accordance with the manufacturer's instructions to apply electrostatically charged and uncharged dust clouds to coffee trees. A copper dust was used and chemical estimates were made of the deposits on the whole leaf surface, the upper leaf surface, and the under leaf surface.

MOLLUSCICIDES

Laboratory Work

Colonies of *Biomphalaria pfeifferi nairobiensis*, *Bulinus tropicus*, and *Limnaea natalensis* have been established in the laboratory.

Tests with a new molluscicide, Bayer 73, were carried out. Results showed that at a concentration of 0.5 parts per million, there was no kill of *Bulinus* or *Limnaea*, and a 60 per cent kill of *Biomphalaria*. At 1 p.p.m. there was 100 per cent kill of *Biomphalaria* and *Limnaea*, and an 80-85 per cent kill of *Bulinus*. It was found that a 12 hour exposure to the substance produced the same results as the recommended 24 hours.

Field Work

An analysis of data from snail population studies in Nairobi River indicates that the bamboo trap method, over a period, provides consistent and repeatable data for *Biomphalaria*, *Limnaea*, and *Bulinus*, but that the catch-to-catch variations of the last species are greater than with *Biomphalaria* and *Limnaea*.

A constant-head device with continuous agitation was designed and built for accurately and continuously dispensing suspensions of wettable powders into snail habitats over long periods of time. In a field trial over 12 hours the apparatus worked to an overall accuracy of over 99 per cent.

Molluscicide Bayer 73 was applied to the Nairobi River (flowing at 3.1 cusecs) at a dosage of 1 part per million for twelve hours. This achieved a total eradication of all snails and snail-eggs for at least three miles below the application point. Observations over a longer distance were not possible. Fish and frogs were also killed.

Some two and a half miles below the application point the river was joined by a tributary flowing at 0.7 cusec, but no snails survived even in the greater dilution below this point. As the suggestion is that of over-dosage, it is planned to repeat the experiment at 0.5 p.p.m. and over a longer stretch of the river.

MISCELLANEOUS

The Drift of toxic chemicals released from a low flying aircraft

Experiments have been carried out to determine the drift downwind of chemicals released from an Auster J-5G aircraft flying at about 10 ft. above the ground. The solution used was dyed Shell "Diesoline". Some details have already been published by Yeo, Akesson, and Coutts (Nature, 1958, 183, 131) of the results obtained with a spray having a mass median diameter of 200 microns. Other experiments have been carried out, using the Britten-Norman "Micronair" equipment to produce a coarse aerosol with a mass median diameter of about 60 microns. For convenience the results have been calculated for an emission of 100 c.c. per yard of flight; the airborne concentrations, expressed in terms of the amounts passing a vertical area at right angles to the wind, were sampled at a height of 3 ft. by means of cascade impactors (May, 1945, J.Sci. Instrum., 22, 187). For this test the wind speed at 5 metres was 12 ft. per second and the turbulence factor (Yeo and Thompson, Nature, 1953, 172, 168) was $+ 2 \times 10^{-3}$. A comparison with the results obtained with the coarser spray suggests that the coarse aerosol gives rise to a considerably greater drift hazard, but it seems most probable that the dosage distributions will be considerably affected by the degree of atmospheric turbulence.

House spraying with portable "Air Blast" Sprayers

At various times the suggestion has been made that small power-driven "Knapsack" sprayers might be useful in applying insecticide to the interiors of African houses, particularly when the houses were larger and taller than usual, and difficult to spray with the conventional lance equipment. Some estimates were therefore made of the deposits upon ceilings at various distances from the nozzle of the "Motoblo" air blast sprayer (Type 55).

The nozzle was held vertically, and slowly moved across the ceiling at about 2.5 ft. per second. Dyed water was used, and the deposits estimated colorimetrically. The dosage patterns were determined, as was the recovery of spray from the ceiling. Recoveries were satisfactorily high for distances up to 5 ft., but had fallen to only 20 per cent at 9 ft. At the shorter distances the dosage pattern was very peaky, and only 4-5 inches wide.

Laboratory Equipment

A nozzle testing table, based on World Health Organisation specifications, has been constructed and works well for fan-type nozzles. A different type of collecting surface, which separates the deposit from each square inch of surface, is being made to assess the performance of hollow cone nozzles.

An automatic dispensing device for attachment to the "Agla" micrometre syringe has been made to facilitate the topical application of insecticides to individual insects. (Misc.Rep. 215 see p. 417 of this issue). With the same end in view two micro-applicators for attachment to microscopes, as described by Hadaway (Porton Report No. 116), have been constructed. With these, topical applications of 0.009 ml can be made.

Bioassays

As a check on the chemical assessments of insecticide in soil in the experiments on persistence reported in the Annual Report for 1957-58 bioassay tests using adult Aedes aegypti were carried out.

A surface on which to expose the insects was prepared by filling a petri dish with the sample to be tested and packing the soil to form a smooth level surface.

2-5 day old female Aedes aegypti were exposed to the surface for 5, 15, 30 and 60 minutes and the percentage mortality 24 hours later recorded. Exposure times to give 100% mortality are given in the table.

	Exposure Time in Minutes			
	15	30	60	Chemical estimates of amount of insecticide: p.p.m. in soil
Aldrin emulsion	100%			149
Aldrin dust	100%			101
Isodrin		100%		153
BHC emulsion		100%		28
Endrin			100%	166
DDT			90%	148
BHC dust			Nil	46

The acetone extract of a suspected insecticidal plant (tentatively identified as *Lantana salvifolia*) was shown to be toxic to *Aedes aegypti* larvae. More comprehensive tests are being carried out on a larger sample of the plant material.

Determination of residues of organo-phosphorus insecticides on plant material

Satisfactory estimations of parathion, malathion and diazinon residues on coffee leaves have been obtained by the following procedure:-

> A chloroform or light petroleum extract of the leaves is evaporated to dryness under reduced pressure and the residue is digested with sulphuric and perchloric acids. Total phosphorus is then determined colorimetrically by the method of Fogg and Wilkinson, *Analyst*, 1958, *83*, 406. It is important to note that copper interferes with the colour development.

FILARIASIS RESEARCH PROJECT, FIJI

Residual Spraying

Mau village was sprayed for the third time in January, 1959. The previous sprayings have had a prolonged effect in reducing the number of *Aedes fijiensis* captured by daytime fogging, but night bait catches within the houses and larval searches have shown no effect on the *fijiensis* population.

Larval Control

Breeding of *Culex fatigans* in ground water was inadequately controlled by weekly treatments with Shell Malariol HS or dieldrin pellets. Treatments are now being made at 5 day intervals. In pit latrines, breeding was controlled by the use of old gear oil.

The extension of the radius of clearing of *Pandanus tectorius* from 300 to 500 yards at Wainiyambia has had little apparent effect on the breeding of *A.fijiensis*. In February, 1959, *P.thurstonii* was treated with dieldrin suspension in case breeding was occurring there. However, increased catches, three weeks later, probably due to wetter conditions, indicated that these mosquitoes had come from *P.tectorius* over 500 yards from the village boundaries.

Successful control of *Aedes pseudoscutellaris* in bamboo pots has been obtained for 20 weeks with 5 g pellets of dieldrin-in-cement at 16⅓ or $2\frac{1}{2}$% dieldrin or 16% BHC. In crab holes pellets have killed some crabs and suppressed breeding of *Aedes polynesiensis* and *A. pseudoscutellaris* for about two months.

Control of breeding in coconut husk piles has been attempted by spraying with $2\frac{1}{2}$% dieldrin suspension and by thatching with leaves to increase run-off of rain thus reducing many potential breeding places. Both methods are effective initially.

Crab Control

Land crab holes are a prolific source of *A. polynesiensis*. The best method of control is baiting with 5 or 10% BHC (10% or 20% BHC 50% W.P.) or $\frac{1}{2}$% aldrin in rice bran. One application gives over 90% kill of crabs. Two experiments to determine the rate at which an area cleared of crabs will be reinvaded, have been laid down; they indicate a relatively slow rate of reoccupation.

Drug Treatment

In the Rewa area, a blood survey made 6 months after the first treatment showed a reduction in microfilarial incidence of 49%. Reduction in microfilarial intensity (positives only) was 87.5%. A second treatment of hetrazan was given in January-February, 1959.

WEST AFRICAN FUNGICIDES TEAM

Method for Assessing Fungicides for Control of Black Pod (*Phytophthora palmivora*) of Cacao.

Field harvested pods are suspended by string in "cages" 9" high by 4" x 4" constructed of $\frac{1}{8}$" brass rod. The pod, in its cage, is placed on the centre of a turn-table, rotating at 33 r.p.m., and is then sprayed from the lateral position with an aqueous suspension of the fungicide. Spraying is by means of an Aerograph type FN504 precision sprayer operating at 5 lb. per sq. in. pressure using a No. 1 nozzle (which gives an emission rate of about 1 c.c./sec.). Particular care is necessary in standardising the direction of the spray emission, so a pointer traversing a fixed angular scale is attached to the nozzle. The distance from nozzle to pod is 30".

The sprayed pod is then allowed to dry off before being placed still suspended in its cage, in a polythene bag. A moist wad of cotton wool is placed in the bottom of the bag which is closed with a rubber band. Visqueen polythene 250 gauge 10" tubing heat-sealed at one end has been found suitable for the bags. It is thus ensured that the pod is stored in a humid atmosphere. Overnight the sprayed pods, together with a number of pods not treated with fungicides, also in bags, are chilled in an air-conditioned room, the air temperature of which is approx. 10°F below ambient. The following morning the cooled pods are removed from the air-conditioned room, and taken from their polythene bags. The caged pod is then rotated slowly on a small turn-table and sprayed with a zoospore suspension, prepared from infected pods, using a throat spray blown by a gentle compressed air supply.

The inoculated pods are then transferred back into their polythene bags, care being taken that the moist surface does not rub against the bag walls. When all pods have been sprayed they are returned to the chilled room and the air-conditioner is switched off. The temperature of the pods rises slowly to normal, the air within the bag remaining saturated. After 4 days a number of lesions will have developed on the pod, approximately 30 on the pods not treated with copper fungicide and lesser numbers on treated pods. These lesions vary from water soaked spots to easily recognised circular areas of black pod some 1 cm. in diameter. The numbers of lesions are determined and the mean number for each fungicide treatment calculated. An approximately linear dosage/response curve is obtained when the number of lesions found on treated pods, expressed as a percentage of those on untreated pods, is plotted against surface deposit on log./probit paper.

The following broad results were obtained from 8 fungicide assessments carried out.

(1) The mean number of lesions on untreated pods was 30.

(2) One commercial fungicide containing cuprous oxide was used as a standard in all the trials and, when the degree of infection at a variety of different spray concentrations is plotted on to log./probit paper, one obtains a medium toxic spray concentration, for 9 sec application to pods, of 0.03% w/v.

(3) An approximately linear relation between the deposit on pods, chemically determined, and the spray concentration was obtained with this fungicide:

$$d = 5\ C.$$

Where d is the deposit in microgm per sq.cm.
C is the fungicide spray concentration in gm/100ml. water.
Thus the medium toxic deposit = 0.15 microgm Cu./sq.cm.

(4) The range of deposits on the various pods was approximately ± 15%, though different parts of the same pod sometimes showed somewhat wider variations. Attempts have been made, using Kiton Red indicator solution and paper cylinders to simulate pods, to define the conditions which give least variability.

(5) A few comparisons of the standard fungicide with other have been carried out. Insufficient data were collected to give firm results but two copper oxychloride fungicides, which have not proved too successful in the field, were appreciably less effective in these tests. Similarly a cuprous oxide fungicide, which during storage in W. Africa has deteriorated in suspensibility and which might therefore be expected to be of low efficiency due to uneven spraying, was in fact much less effective in the laboratory experiments.

(6) Sedimentation tests of the various fungicides in aqueous suspensions using a pipette sampling technique have been carried out. The most effective fungicides were found to have a few per cent of the total copper as particles of < 0.0002 cm diameter, while less effective formulations had lower proportions. It is not possible yet to be certain that this relationship is real, but it is in keeping with experience in some other fungicide problems.

PROGRESS REPORT OF COCONUT PEST RESEARCH, ZANZIBAR, FOR THE PERIOD OCTOBER 1st 1958 - MARCH 31st 1959 AND FINAL SUMMARY

(An assessment of the first year's results from protecting 100 acres of coconuts from *Pseudotheraptus wayi* over a full year was reported in PANS (A), 1959, 5, (1), pp.66-68.)

Vidaka Damage Rate

It is stated that the last (10th) application of 10 DRDK in September 1958 was most effective and that it is almost certain that complete eradication of *P.wayi* was obtained from the whole 100 acres. As a result of this spraying the V.D.R. over the whole area fell to nil by the 7th week, remained at this level for 2 weeks and then gradually increased but was still less than 10% 27 weeks later.

In previous reports the value of residual deposits have been questioned since the palms are continually opening up new leaves and flower spadices, which are unsprayed. Recent observations have shown that when adult *P.wayi* fly from palm to palm they frequently land on the older leaves, which hang downwards around the palm; then after resting on these for a short period, fly into the crown. It would appear that if these leaves have a good coverage of residual insecticide, the flying adults are killed, and although they may deposit a few eggs before they die, these are not sufficient for rapid repopulation. It is suggested that if larger areas were sprayed, one spraying per annum might be effective. The cost of insecticide per acre, applied at 3 gal./ac. was 18/-; 35-45 acres can be sprayed per day.

Analysis of the Results from the First Two Years

For the purposes of analysis 78 one acre plots (out of 128 acres sprayed) of the experimental area and 93 one acre plots (out of 128 acres) of the control area were considered. These plots were divided into groups according to the number of palms present as follows:

Experimental area	Control area
34-45 palms/ac.	23-30
46-55	31-35
56-65	36-40
66-75	41-45
76-94	46-50
	51-62
Average 56.5	Average 36.8

The 1956/57 and the 1957/58 yields for each of these acre plots were recorded, together with the number of palms with Oecophylla sp.

Consideration of experimental area pre-spraying data indicates that: the number of colonies of Oecophylla sp. (nesting in palms) per acre increased significantly with the density of palms per acre; there is no correlation between the yield per palm at various palm densities; the yield per acre is correlated with the density of palms per acre - the higher the density the higher the yield (per acre but not necessarily per palm); the yield and per acre is correlated with the number of Oecophylla colonies per acre.

After two years of application of 10 DRDK P.wayi damage was reduced to 8% in the first year and 16% in the second year. Analysis of the yields during this period indicates that: yield per palm increases with decrease of number of palms per acre; yield per acre does not correlate with palm density per acre; and yield per palm per acre does not correlate with number of Oecophylla colonies.

In the control area the findings are similar to those from the experimental area prior to the application of insecticide. These are, yields per acre correlate significantly with density of palms per acre, but there is no correlation between yield per palm and density, nor in the case of the control is there any correlation between the numbers of colonies of Oecophylla per acre and yield (either per acre or per palm.)

If the high density experimental area (i.e. 76 or more palms/acre, average 85) alone is considered, this area yielded an average of 3,487 nuts per acre before spraying and 3,488 nuts after spraying (41.3 palm/year) - this is in spite of reducing P.wayi damage to 8% in the previous year. It appears that under the prevailing climatic and soil conditions an acre can yield a maximum number of nuts, and these can be obtained by either eliminating P.wayi or planting the palms so closely together that there is sufficient food for P.wayi and yet the palms are still able to produce as many nuts as climatic and soil conditions allow.

It is suggested that one answer to the P.wayi problem might be to plant the palms close together at 85 to 90 per acre, when higher yields per acre can be obtained than by controlling P.wayi.

Biological Control

An account is given of the life-history of a strepsipteran parasite (at present unidentified) which renders the female P.wayi sterile, and possibly causes a high death rate amongst the early instars. It is suggested that this may well be a useful parasite for controlling P.wayi. Experimental breeding of P.wayi in the laboratory is also described. P.wayi lived better on freshly picked vidaka than fallen vidaka. It was found that bright green vidaka (most vidaka are greenish-brown or brown) were not favoured and resulted in a high death rate owing, in some cases to refusing to feed, and in others, digestive upsets. It is suggested that if a variety of coconut with green vidaka exists, providing yields and copra content are suitable, such palms could be used for planting material.

The reports conclude with observation on Prodenia litera F. (Lepidoptera-Noctuidae) which damages about 1% of the vidaka.

WEST AFRICAN COCOA RESEARCH INSTITUTE
QUARTERLY PROGRESS REPORT No. 51, JULY-SEPTEMBER 1958

Pathology Division

Insect Transmission Studies

The ability of 10 vector species to transmit 14 unrelated cacao virus isolates is being investigated. Successful transmissions of some of these isolates have been obtained with Pseudococcus concavocerarii, Planococcus citri and Ferrisiana virgata.

Studies on Black-Pod Disease

Fungicide Spray Control Trials. Mid-crop pickings on the three field experiments incorporating fungicides to control black-pod disease have been small. There are, so far, no treatment effects on yields of wet beans which, in these experiments, are being taken as the final measure of control.

Pod Susceptibility Experiment. At the beginning of the year 150 of the trees on this experiment were split into pairs to study the development of young fruits protected from infection by Phytophthora palmivora Butl. All fruits on one tree in each pair are being sprayed, at weekly intervals, with a strong concentration of Perenox, with the object of completely eliminating spore infections. Only 3 "black-pods" have been recorded on these trees compared with 51 on the untreated.

Entomology Division

Capsid Control Trials

Trials on the comparison of endrin, gamma-BHC and aldrin continue. (See PANS, 1959, 5, (1), p.124 for details.)

Laboratory Assessment of Insecticides

Preliminary investigations have begun into the efficacy of various gamma-BHC formulations, and a comparative laboratory bioassay technique, using capsids, is being established.

Mealybug Studies - Oyoko

See PANS, 1959, 5, (1), 124.

The second application of the double dieldrin treatment, begun in June, 1958, was completed during the present quarter. Ant populations fell rapidly to a level similar to that recorded after completion of the first treatment in 1956/57. Mealybug populations also declined, following ant control, and during the month of September no adults of Pseudococcus njalensis were found in counts to hand height on the trees. In the untreated area mealybug populations are following a natural seasonal decline, though their numbers have not decreased to anything approaching those of the treated area.

Ant/Mealybug Control Trials - Series II

See PANS, 1959, 5, (1), 125.

Between 5th and 12th of August dieldrin and dieldrin/coumarone were applied to the appropriate treated area plots. Ant populations were immediately affected but to an extent which did not differ appreciably between the two insecticidal treatments. The reasons for this unexpected event are being investigated in the laboratory. Mealybug populations have also declined but it is as yet too early to say if these show any differences between the two treatments.

Marmara Studies

Populations of this moth (Lepidoptera, Gracillariidae) have begun a natural seasonal increase coincident with the beginning of the main-crop period. Under natural conditions *Marmara* appears to be held in check by three species of parasitic Hymenoptera, of which the adults of two have been reared and despatched to U.K. for identification. During peak populations the rate of parasitism is extremely high, being in the region of 60 *per cent*, the greater part of which is due to an endoparasitic chalcidoid. In addition to this a further 18 *per cent* have been recorded as dying from unknown causes.

WEST AFRICAN COCOA RESEARCH INSTITUTE
QUARTERLY PROGRESS REPORT No. 52 OCTOBER-DECEMBER 1958

Pathology Division

Insect Transmission Studies

See p.401 of this issue.

Results are incomplete, but those to date indicate that on the basis of differential vector transmission three groups of isolates may be readily distinguished. The first group contains isolates which are transmissible by *F. virgata* (Ckll.), but not by *P. adonidum* (L.) The second group contains isolates which have been transmitted by *P. adonidum*, but not by *F. virgata*. An isolate of the third group, that from Asalu in Nigeria, has not been transmitted by any of the 10 mealybug species.

Entomology Division

Mealybug Studies - Oyoko

Following the second application of the double dieldrin treatment crematogasterine ant populations fell to a lower level than that recorded after the initial double treatment with dieldrin. This is probably because the nests individually had not grown to pre-treatment size though they had regained pre-treatment numbers, and the closer spacing of the two applications in the second treatment may also have been more effective.

Except in three small farms lying close together on the margin of the treated area, populations of Pseudococcus njalensis Laing fell to zero (as recorded in counts to hand-height) during the second month after completion of the dieldrin treatment. Counts on complete trees (felled as virus contacts) followed a similar pattern, P.njalensis populations declining to a very low level. In the last two months of the quarter only three trees were recorded with more than one adult P.njalensis.

Ant/Mealybug Control Trials - Series II

No differential effect has been detected between the dieldrin and dieldrin/coumarone treatments in the ant data. The reasons for this are being investigated in a small field trial designed to compare the efficiency of different dieldrin/coumarone formulations and methods of application.

Pod Fumigation

Pods sent out of Ghana for use as seed are at present dipped in a solution of mercuric chloride (approx. 0.4%) to kill fungus spores. It has been found that this treatment is not adequate to kill mealybugs harbouring in the pods, particularly those which colonise Characoma mines, Attempts have therefore been made to develop a method for fumigating pods, with the following results.

Cocoa sacks, approximately 5 cu. ft. in volume, were provided with a polythene lining and each filled with approximately 170 pods. In each sack three pods infested with mealybugs (placed beforehand in artificial mines made by a cork-borer) were placed in the bottom, middle and top sections of the sack. The sacks were then tied and sealed after a wad of mutton cloth saturated with fumigant had been dropped into the top of the sack.

The fumigant used was a 50/50 mixture of ethylene dichloride and carbon tetrachloride with a range of 1 oz. to 9 oz. per sack. The pods and fumigant were left for 48 hours in the sealed sacks, stacked in an open shed.

The results were somewhat variable owing to tears developing in the polythene liners, but briefly, it may be said that 100% kill was obtained with the 5-7 oz. treatments, as against a 26% mortality in the untreated controls. Germination tests showed no ill-effects from fumigation at the 5 and 6 oz. per sack levels. The method is very promising, but improved liners are necessary.

Ibadan Entomology Section

Shot-Hole Borers

Two experiments have been laid down to investigate the incidence and some possible methods of control of shot-hole borers (Scolytidae) in seedling cacao, and the effects of borer attack on the plants. The insecticidal preparations used are a urea-formaldehyde lacquer containing 10% dieldrin and 4% aldrin when dry, and dieldrin emulsion at 0.5%. In preliminary tests of phytotoxicity, the lacquer formulation was found to be unsuitable for application to unhardened tissues, which were killed within four days of application; no apparent damage was done to hardened stems and seedlings could be treated on the lower portions of the stem.

In one experiment in Ibadan the effects of a single treatment of the lower portions of the stem with the lacquer formulation is being compared with the use of an aqueous emulsion of dieldrin applied only to the lower 12 inches at monthly intervals. Control plants receive no insecticide. The seedlings are not being watered during the dry season, though they were liberally watered during the first fortnight after planting in October.

Shot-hole borer damage was first noted in mid-November and by the beginning of December 15.4% of the 480 seedlings in the plot had been attacked. This attack had increased to 34.8% of all seedlings by the end of the month, being slightly heavier on those sprayed with emulsion than on the untreated ones (41.8% and 36.7% respectively) but some control was obtained using the lacquer (24.2% attack).

Similar results have been obtained at Akure where a larger trial was laid down using 1,200 seedlings. Here a third insecticide treatment of 0.5% dieldrin emulsion has been included and applied to the whole plant as opposed to the lower portions of the stem only. The percentage of seedlings attacked was as follows:

lacquer: 13.7%
aqueous emulsion up to 12 inches: 30%
aqueous emulsion overall: 21.7%
untreated 26.3%

In this experiment half of the plots in each treatment are receiving 1 gallon of water per plant twice weekly during the dry season. As the rain continued well into December at Akure watering was not started until the middle of that month and no effect has yet been noticeable.

REPORT ON PROGRESS OF RESEARCH BY WEST AFRICAN TIMBER BORER RESEARCH UNIT, (W.A.T.B.R.U.)

Ambrosia Beetle Control

Experiments were conducted to prevent or reduce, beetle infestation of logs by chemical treatments.

A wide selection of basic ingredients such as aldrin, endrin, dieldrin, gamma BHC and DDT were submitted for testing in addition to a variety of oils and wood preservatives. Each active ingredient was used in water and oil formulations at various dilutions. It was evident, that at any level of concentration, irrespective of formulation, gamma BHC was by far the most effective insecticide and was capable of providing a very high degree of protection. On the basis of this, gamma BHC trials using water, water-paint, oil, resin and grease formulations, were conducted in both Ghana and Nigeria.

It was found that under Ghanaian conditions of road haulage of logs, no significant difference in degree of protection was exhibited by oil, water and water-paint formulations, applied to logs devoid of bark. Where bark was present on the logs, water and water-paint formulations, were superior to oil solution of gamma BHC. In terms of percentage protection gamma BHC applied at 0.75% active ingredient, maintained a control value of over 90% for a period of 10-12 weeks. Under Nigerian conditions of water transport, water formulations were ineffective, but oil solutions of gamma BHC on logs devoid of bark gave around 90% protections over a 12 week period when applied at 0.75% concentration.

Experiments with resins and greases, to date, have not produced evidence of any greater efficacy than can be obtained with oil solutions. Some insight has been gained into the technique of treating logs and the rate of application required. Generally it has proved necessary to employ low pressure/high volume sprayers giving coverage of approximately 1 gallon per 100 sq.ft. log surface. Assessments of residual deposits of insecticide on logs after treatment have not been successful. The relative advantages of insecticide treatment at the various stages of extraction i.e. at felling and gantry sites, log dumps and sawmills, have been examined. Where pre-felling treatment has been adopted observations have been made of the results of the various methods used and their effect on the infestation of the trees.

REPORT OF THE WEST AFRICAN TIMBER BORER RESEARCH UNIT, 1955-58

Control of Sawn Timber Pests

Investigations are in progress to assess the merits of dip formulations for lumber. The most successful formulation employed in West Africa is a water mixture of 1-2% sodium pentachlorophenate and an equal amount of borax (as a buffer) and incorporating 0.5% gamma BHC. This formulation, although highly effective against lumber pests and blue-stain, suffers despite the use of borax from some instability. It is also unpleasant to handle particularly when mixing the sodium pentachlorophenate. A further handicap is that there is no convenient way of assessing the concentration of active ingredient in the mixture of the dip tank at any time after the initial charging of the tank. Replenishing the dip tanks is therefore usually inadequate or excessive, and either way uneconomical.

The recent appearance of a patent concentrate, incorporating the fungicide and insecticide, which on dilution gives a highly stable mixture, may solve a part of the problem and the Unit is conducting trials to compare the efficacy of the old and newer formulations. The problem of assessing concentration of active ingredients, however, remains unsolved.

WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH
ANNUAL REPORT 1958

A Study of the fusca Group by Means of a Bait-Ox Fly-Round

A study of the bait-ox fly-round in the forest habitat of the *fusca* group flies has definitely shown that constant catching and killing (for purposes of identification) seriously affects the size of the population. Thus, whereas 1,597 flies were captured in the last five months of 1956, only 538 were taken in the whole of 1957, and 291 in 1958. The total catch for 1958 consisted of 83% *G.tabaniformis*, 16% *G.fusca* and 1% *G.nigrofusca*. The tremendous initial catching-out effect in late 1956 would have masked any seasonal fluctuations in fly density, but during the last two years there has been evidence that this mixed population reaches its maximum in the middle of the rains and falls to its minimum during the dry season.

A Study of the fusca Group by Means of Fly-Marking Experiments

Having observed the serious catching-out effect, another area of the forest was selected in which to study the ecology of these tsetse, but this time the fly marking and release technique was used, even though accuracy of identification was sacrificed to save destruction of the flies.

In a dry season experiment the result from samples caught and killed for identification showed that three-quarters of the population consisted of G. tabaniformis and one-quarter of G. fusca. Using the same period of 22 days for marking and recapturing flies that came to a tethered ox, and again counting only those flies caught once per day, the total number taken in the dry season experiment was only 7,694 as compared with 14,577 taken in the wet season. However, the female proportion was very similar, being 70% as compared with 65% for the rains.

Nocturnal Detection of Resting Tsetse with Ultra-Violet Light

East African workers have recently found that the nocturnal habits of tsetse-flies can be investigated by marking them with luminescent paint which will show up under the rays of an ultra-violet lamp. Following on these observations, work was started, with a battery-powered ultra-violet lamp, and flies marked with luminescent powders mixed with gum - a mixture which was not toxic to the flies.

Attempts to detect G. palpalis which had been marked and released, even as late as the morning of the nocturnal search, were unsuccessful, owing to the rapid dispersal of the flies up and down stream. The results obtained to date have been from flies released just before dusk at the end of the wet season. On the nights when rain did not interrupt the experiment, 51 flies were detected out of 215 marked. About half the flies were resting within one foot of the ground, the remainder being found at an average height of $4\frac{1}{2}$ feet with only very few as high as 8 to 10 feet; there appeared to be no difference between the sexes in resting-site preference. Most flies were located on the upper surface of small leaves, a few on slender creepers, but none on tree-trunks. Should it be found that within a period of a few days almost every fly rests on vegetation within one foot of the ground, a great economy in the use of insecticide would be possible. The work has been held up by defects in the machine, but these have now been rectified.

EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANIZATION ANNUAL REPORT OF THE EAST AFRICAN AGRICULTURAL AND FISHERIES RESEARCH COUNCIL, 1958. EAST AFRICA HIGH COMMISSION

Entomology

Sampling methods for wild tsetse populations continue to be improved. The shortcomings of the ordinary "fly-round", in which assistants catch flies attracted to them while marching over a set route, have been increasingly recognized. New methods of sub-division of the round and analysis of results have improved the prospects of relating fly catches to environmental factors. Traps, also, have been increasingly used and offer the advantage that they catch a larger proportion of female flies than does the fly-round, a consideration of importance when infection rates are to be examined. The importance of locating resting flies has been realized in the last few years - both for deciding the most effective ways of applying insecticides and for obtaining blood-fed flies to determine the species of animal host important in affording them their food. It has been known for some year that flies disappear from their daytime resting sites on the trunks and branches of trees at about sunset. The introduction of a marking technique using reflecting paints has allowed the location of considerabl numbers of flies by night - on the leaves of the trees.

Physiological studies on the water and fat consumption of flies have continued and offer valuable possibilities for assessing the degree to which the metabolism of flies is upset by interference with their habitat by various methods of bush clearing. A study of the effects of a particular method is in progress in Ankole, Uganda.

The identification of the animals fed on by tsetse has continued and a large body of information is now available. It appears possible that tsetse may be more catholic in their choice of host that was previously thought; in Uganda in areas in which game is being destroyed percentages of blood meals from cattle as high as 60 have been recorded.

Studies on the predators attacking tsetse have indicated that certain flies and spiders may be important.

EAST AFRICAN INSTITUTE FOR MEDICAL RESEARCH REPORT, 1957-58

Filariasis

By hatching mosquito eggs and rearing the larvae in solutions containing Na22, it has been possible to obtain mosquitoes showing a high degree of radio-activity. It is hoped, by feeding these creatures on subjects with microfilariae in the blood, to obtain infective larvae of *Wuchereria bancrofti* which are themselves radio-active: if these are in turn introduced into the body through the bite of the mosquitoes harbouring them, it is hoped to follow their migrations through the tissues with a directional scintillator head.

Blood smears from dogs and cats throughout the Territory have been examined in a search for "malayi-type" (or "bancroftian-type") microfilariae, but none has been found. Smears from animals of many other species have also been examined, but no microfilariae resembling human types have been found. An unidentified filarial worm, living in the peritoneal cavity of the mongoose - *Herpestes sanguineus* - was found. The microfilariae exhibit a nocturnal periodicity. Neither *Culex fatigans* nor *Aedes aegypti* will transmit the infection.

The effect of a blood meal on infective larvae of *W.bancrofti* in the head, thorax and abdomen of *C.fatigans* was studied. It appears that the majority of larvae in these parts are attracted to, and pass out of the proboscis when a mosquito feeds.

FEDERAL MALARIA SERVICE, NIGERIA, ANNUAL REPORT FOR 1958

Western Sokoto Malaria Control Project

Parasite rates, especially those among infants and children, indicate that although transmission of malaria has not yet been entirely interrupted in any part of the treated area, it has been markedly reduced. This reduction is most effective in the areas which have throughout been treated with DDT or have received BHC followed by DDT. Less improvement is noted where DDT has followed dieldrin, and the least effect is seen in the most recently added areas of the expansion, where BHC followed by DDT or DDT alone have been in use for a relatively short period. But even in the centre of the longest established DDT area, examinations following treatment of children with antimalarials have shown that transmission does still occur. Attention has now been drawn to the important role of the nomad Fulani as a source of infection and attempts are being made to protect them, both by spraying of their temporary habitations and by drug treatment.

The most interesting entomological point established in the last year is that the mortality in *Anopheles gambiae* entering sprayed huts, as judged by examination of window traps, is often not more than 20%-30% in the 24 hours.

OBSERVATIONS ON THE NATURAL HISTORY OF HUMAN FILARIASIS IN FIJI

A Report to the Secretary of State for the Colonies on Investigations Conducted over the Period 1954-1956

C. B. SYMES

Author's Summary

1. Sixteen species of mosquitoes have been recorded in this study. Data are presented on the breeding, distribution and prevalence of some of them, and the manner and degree of their contact with people.

2. Four species -

A.pseudoscutellaris
A.polynesiensis
A.fijiensis
C.fatigans - appear to be concerned in the transmission of W.bancrofti (Pacific form). The first three exhibit about equal degrees of vector - potential, as determined by laboratory infections. C.fatigans is of a lower order but its wide distribution and large numbers probably more than balance this lower potential.

3. The development period of W.bancrofti in Culex fatigans is usually about two days more than the period in the other three species. Development appears to be slower in all species during periods of lower temperatures.

4 C.annulirostris, A.aegypti, A.vexans and C.sitiens appear to be intolerant to the development of W.bancrofti in them. The majority of micro-filariae taken up by them die before or during the first stage of development. The tolerance to developing infection of A.horrescens has yet to be determined, if its distribution and numbers warrant the effort.

5. Evidence is given indicating a broad relationship between the density of microfilariae in the blood of donors and the amount of infection in vector mosquitoes fed upon them. It is also shown that mosquitoes may become lightly infected after feeding upon people in whose blood microfilariae have not been found by the ordinary methods of examination.

6. Infections of W.bancrofti in the legs of A.pseudoscutellaris are apparently not of great significance. Other species have not been examined.

7. Some data are presented suggesting than when A.pseudoscutellaris feeds upon blood containing large numbers of microfilariae, it retains in the blood in its stomach immediately after the feed, greater numbers of microfilariae than would be expected in an equivalent amount of blood taken from the donor. It is also indicated that during the first 12-24 hours after the feed some fifty per cent of the microfilariae in the stomach are excreted, or lost in some other way.

8. Inadequacies in microscopical determination of the presence and numbers of microfilariae in blood are indicated. It is considered that the incidence of the infection in the population sampled is in the region of 30%, and that the incidence of clinical filariasis only is about 5%.

9. Incidence and intensity of infection by age groups follows roughly the usual pattern - low levels in the early age groups increasing to high levels in the 30 years and over. About four per cent of the 0 - 4 age group had microfilariae in the blood, the youngest being between one and two years.

10. Evidence on racial distribution of infection is inadequate; but it is suggested that any differences that may appear to occur in incidence or intensity in the various races result from environmental factors and not from differences in tolerance or 'resistance' to the infection.

11. Observations on the numbers of microfilariae in blood over 24 hours confirm the frequent fluctuations in numbers, and suggest a tendency to a peak in numbers in the afternoon or evening.

12. Short term effects of various dosages of Heratzan on the numbers of microfilariae in peripheral blood are shown.

13. Some preliminary experiments are reported on the reduction by trained Fijian mosquito inspectors of A.pseudoscutellaris and A.polynesiensis by removal of breeding facilities around villages. Results were poor.

14. Preliminary experiments on the control of crabs with insecticides indicated that treatment of holes with dieldrin and with pentachlorophenol may be worthy of more study.

15. Experiments to determine the effect of 'residual' deposits of insecticides in Fijian houses on day populations of Aedes fijiensis and Culex fatigans have been started. Both DDT and dieldrin in wettable powder form appear to be promising.

16. Suggestions are made for a continuation of study, including field experiments.

17. Brief notes are submitted on the mosquito vectors of the dog filaria (Dirofilaria immitis) and on the development in mosquitoes of a filaria discovered in fruit bats (Pteropus hawaiensis).

TRIALS WITH A NEW MOLLUSCICIDE

R. FOSTER, C. TEESDALE, G. F. POULTON.
Colonial Pesticides Research Unit, Arusha, Tanganyika,
Miscellaneous Report No. 232. May 1959.

This report deals with laboratory and field trials of Molluscicide Bayer 73 (2-hydroxy-5,2'-dichloro-4-nitro-benzanilide) which was reported by Goennert and Schraufstaetter to the International Congress on Tropical Medicine at Lisbon (1958) to be effective against various snail species in concentrations of 0.3 parts per million upwards.

Laboratory Trials

A 70% wettable powder formulation was used to prepare solutions in distilled water. Trials were carried out using Biomphalaria pfeifferi nairobiensis, Bulinus tropicus, and Limnaea natalensis. Snails were exposed individually in 3" x 1" specimen tubes for either 12 or 24 hours, then washed in distilled water and transferred to clean tubes containing distilled water for a further 24 hours, when the kill was assessed. Boiled lettuce was provided as food both during and after exposure.

Results

A concentration of 0.5 p.p.m. was ineffective against Bulinus tropicus with both 12 and 24 h exposure. Biomphalaria pfeifferi nairobiensis, however had a mortality of 60% with both 12 and 24 h exposure. At a concentration of 1.0 p.p.m. there was a 100% kill of Biomphalaria pfeifferi nairobiensis and Limnaea natalensis with both 12 and 24 h exposure. Bulinus tropicus showed an 85% mortality with a 12 h exposure and an 81% mortality with a 24 h exposure. At neither concentration was there any tendency for the snails to escape from the water.

Field Trials

A 60% wettable powder formulation was used to treat a stretch of the Nairobi River in Kenya. The river contained principally Biomphalaria pfeifferi nairobiensis, Bulinus tropicus, and Limneae natalensis, although Anisus, Physa and a single Physopsis were also recorded.

A dispenser giving a flow of 2.5 ml./sec was used, and the river (with a flow of 3.1 cusec.) treated with a continuous dosage of 1 p.p.m. for 12 hours. The snail population was sampled by means of bamboo rafts, 12 in. square. The experimental reach contained 30 such traps, the upper 20 at 100-yd. intervals and the lower 10 at 200-yd. intervals. The molluscicide was introduced immediately below trap 9, giving a sampled reach of 900 yd. above the dosing point to serve as a control area, and a sampled reach of 3,100 yd. downstream of the applicator. Beyond the sampled area observations showed that snails continued to occur abundantly for a further mile or so. Samples of river water taken six to seven hours after the start of the application were analysed chemically by the colorimetric method of Strufe.

Results

Snails and eggs disappeared completely from the treated section following the molluscicide application. Chemical analyses showed that the molluscicide concentration was maintained in the river for a distance of 1,500 yd. downstream, after which it declined to zero in the following 400 yd. From that point onwards snails were recorded, eggs being found additionally for 400 yd. upstream into the molluscicidal area. Thus the chemical and malacological data suggest that the molluscicide had progressed only approximately one mile downstream in about six hours, This indicates a mean progression of about 300 yd. per h, and the rate must have been considerably slower in certain regions of deep water and heavy vegetation. The fact that the molluscicide eventually proved effective for at least a further two miles indicates a high degree of efficiency for the product under favourable conditions in natural waters.

By the following day snails and eggs had all disappeared. Searches beyond the trapped area revealed no snails for a further mile, beyond which the river becomes unfavourable to the animals because of sewage discharge. Hand searches between the traps also failed to reveal any snails. Thus the application was apparently effective for a minimum distance of approximately three miles below the dosing point. Anisus and Physa, which prior to treatment were recorded regularly in small numbers, have not been recorded since the application. Throughout the treated area, fish were completely eradicated and many frogs also succumbed. The fish died within the first six hours of the application. No phytotoxicity was evident.

Discussion

This molluscicide is effective against both snails and eggs over long distances at low concentrations, does not cause snails to leave the water and so avoid intoxication, and is not materially affected by the presence of vegetation and large, slow-running pools in the course of the river. Furthermore, its mammalian toxicity is very low (Goennert and Schraufstaetter 1958), it is easily handled, and is not phytotoxic in the concentration employed.

Despite the laboratory results there is some suggestion that the dosage of one part per million was excessive. Below the last trap the river was joined by a tributary, which at the time of the application was flowing at 0.7 cu.ft. per sec. In the greater dilution beyond this point snails were still apparently eradicated. Further trials are planned at a reduced dosage. Such a reduction may have a subsidiary advantage, in that it will reduce the concentration of molluscicide below the makers' stated lethal limit to fish of one part per million. Thus it may eventually be possible to control snails with a dosage not toxic to fish. In the present experiment a few dead fish were observed in the greater dilution below the tributary, but these could have been washed down from the upper reaches.

Reference

Goennert R and Schraufstaetter E. (1958). Report to the International Congress on Tropical Medicine, Lisbon.

FURTHER INSECTICIDE TRIALS ON THE MAIZE STALK BORER IN TANGANYIKA, 1957

P. T. WALKER, Colonial Pesticides Research Unit, Porton.
Report No. 161. March 1959.

Further trials against Busseola fusca are described. The effective rate of each insecticide per acre overall is given in brackets.

Trial 1. DDT dust (7½ oz.), DDT emulsion spray (5-6 oz.), DDT emulsion spray + resin additives (4½ oz.), gamma BHC emulsion spray (7 oz.), and gamma BHC emulsion spray + Aroclor resin (6-7½ oz.)

Trial 2. One early application of DDT emulsion (4.8 oz.) compared with two applications (1½ oz. and 2.9 oz.) at an interval of two weeks.

Trial 3. Malathion dust (5½ oz.) was compared with malathion emulsion (5-6 oz.) and malathion emulsion (6 oz.) + Aroclor resin.

Trial 4. Two applications of endrin emulsion (4½ oz. and 7 oz.) are compared with lighter applications (1½ oz. and 2 oz.), applied to the whole plant, and also applications (1½ oz. and 2 oz.) to the stalks only.

Results

Endrin gave the greatest control effect. An emulsion of 0.037% applied at 1½-2 oz. of endrin per acre overall, reduced a 25% infestation to 4% after only two applications, at fourteen days interval. This compares with the effect of an emulsion of 0.05% DDT at 2 oz. per acre in 1956, after three applications at ten day intervals. At the same time (1956), 1½ oz. of endrin per acre or 0.03% emulsion reduced the infestation from 49% to 7½% after two applications. Two applications of DDT 0.095% at 5-6 oz. DDT per acre only reduced the infestation from 40% to 20%, compared with the reduction from 50% to 32%, from 24% to 10½% and from 43% to 13% in three trials with similar treatment in 1956. This confirms the previous conclusions that three treatments are more effective than two, and essential for a good crop under adverse conditions.

The use of 0.08% emulsion gamma-BHC at 7 oz. per acre, after two applications was less effective than DDT, reducing a 40% infestation to 31%. This is also in agreement with the results in previous years, when two applications of gamma BHC emulsion only reduced a 49% infestation to 31%.

Malathion appeared intermediate in effect between DDT and gamma BHC, probably striking a balance between its high toxicity to stalk borer and lack of persistence on the plant. An emulsion at the same rate as DDT, 5-6 oz. per acre overall, reduced a 41% infestation to 23%. Malathion 4% dust was even less effective, although not statistically, when applied at 5½ oz. per acre. It has not been shown superior to DDT dust, but in view of the inconclusive results obtained would be worth further trials.

Spraying the tops of the plants is more effective than spraying the stems only, which is no better than complete absence of spraying, suggests that it is unlikely that a lethal dose is picked up by newly hatched larvae crawling up the stem. The main site of action would therefore be on the upper leaves and inside the funnel.

In the present trials the incorporation of resins appeared to increase the effect of DDT, so that a DDT + resin emulsion formulation could be applied at a lower DDT strength than DDT emulsion alone. Again, results do not conclusively support this, neither do they positively disprove the lack of effect when a chlorinated terphenyl resin, Aroclor 5460, is added to the more volatile gamma BHC and malathion.

The chemical analyses of the amounts of endrin and DDT remaining on the plants immediately after spraying show that from 1.4% to 3.7%

of the amount calculated to fall over the area of one hill (two to three plants) can be recovered from each plant. For example, in endrin treatment (4½ and 7 oz.) a mean of 0.104 (1.7%) mg endrin was recovered from each plant after application of about 6 mg of endrin per quarter square yard. After application of 2.34 mg endrin over the same area, 0.032 mg per plant (1.4%) was recovered. In treatment at 4.8 oz. in trial 2, application of DDT emulsion at about 7 mg of DDT per quarter square yard was followed by recovery of 0.26 mg DDT per plant (3.7%). As the mean number of plants per hill, between two and three, occupy about half the area covered by the spray, it follows that in very general terms about a 95% of the spray falling on a maize hill is lost as drift, run off, or by dripping nozzles.

A possible method of control would be to kill or prevent the emergence of the insects in the "trash bunds" of dead maize stalks. Two experiments were carried out to find whether the application of a heavy spray of DDT emulsion would prevent adult moths emerging into cages placed over sprayed dead maize stalks. Ants attacked the treated and control heaps, however, and no emergence in the control cage occurred. In view of the distances adult moths migrate and the difficulty of spraying widely scattered trash bunds, the method may, in any case, prove impracticable.

NEW APPARATUS

G. F. POULTON. Colonial Pesticides Research Unit, Arusha, Tanganyika.

1. Automatic Dispensing Device for (Agla) Micrometer Syringe. (Misc. Report No. 215)

This device enables the operator to revolve repeatedly the barrel of the (Agla) Micrometer syringe any required number of 0.001 mm divisions. It considerably speeds up the rate of topical applications to insects as no viewing of the micrometer unit is necessary whilst working.

2. Plant Juice Extracting Press. (Misc. Report No. 216)

This press was constructed to compress plant tissues up to 1,400 lb. per sq.in., the extracted juice being collected in annular grooves running near the outside edge of the pressure plate face and discharged along an extension of the groove to the outside edge. The whole press unit can be tilted to facilitate collection of the extracts.

3. Insect to Wall Exposure Plate. (Misc. Report No. 217)

An easily made wall exposure plate utilising Petri dishes is described.

NEWS ITEMS

AGRICULTURAL AVIATION GROUP

An Agricultural Aviation Group has been formed by the Royal Aeronautical Society. The aims of the Group are: to further the use of aircraft in agriculture, forestry, pest control, fertilising, seeding, chemical application and similar subjects and to provide facilities for those interested in such matters to meet and exchange ideas and information.

Enquiries should be addressed to the Secretary, Miss E. C. Pike, The Royal Aeronautical Society, 4, Hamilton Place, Piccadilly, London, W.1.

CHEMICAL COMPOUNDS USED IN AGRICULTURE AND FOOD STORAGE IN GREAT BRITAIN)

Recommendations, for safe use in agriculture and horticulture of the compounds noted below, have been added to those already included in the dossier prepared by the Ministry of Agriculture, Fisheries and Food.

Alkali Arsenites (Sodium and Potassium Arsenites)	Revised: July 1959.
"Allisan Dust" (4% chloronitroaniline)	Issued: August 1959.
Demeton-Methyl (a mixture of demeton-O-methyl (2-ethylthioethyl dimethyl phosphorothionate) and demeton-S-methyl (S-2-ethylthioethyl dimethyl phosphorothiolate))	Revised: October 1959.
"Melprex" (n-Dodecylguanidine acetate)	Issued: October 1959

Copies are obtainable from:

Ministry of Agriculture, Fisheries and Food,
5/8, St. Andrew's Place,
Regent's Park,
London, N.W.1.

WARBLE FLY CONTROL

"Recent work has shown beyond question that regular and thorough inspection of cattle followed by derris dressings properly applied at the right times will greatly reduce and probably in time eliminate the warble fly.

In collaboration with the Veterinary Investigation Service, field trials of a new systemic insecticide have been arranged. This product, originally known in the U.S.A. as Dow ET.57 (0,0 dimethyl 0-2,4,5 trichlorophenyl phosphorothioate) is believed to kill the warble-fly larvae during the early part of the migration within the bovine. This effect needs to be confirmed under our field conditions and in addition it is not certain that the drug is always safe to use. Initial trials at the Laboratory have not, however, indicated more than transient ill-effects when the drug is used at up to 2-3 times the recommended therapeutic dose."

(Report on the Animal Health Services in Great Britain, 1957. Ministry of Agriculture, Fisheries and Food. Department of Agriculture for Scotland. H.M.S.O. 1959.)

FOREST PEST CONTROL

1. Forest Entomology

Much of the section's activity was concerned with studies on the pine looper moth, Bupalus piniarius L. The countrywide pupal survey revealed low levels of population in almost all forests, with slightly higher than normal but not immediately threatening counts only at Tentsmuir and Rendlesham. A further season's detailed sampling was carried out on the sample plot at Elveden, Thetford, and various investigations on the parasites of the pine looper were made. In August some 360 acres at Tentsmuir Forest were treated with a DDT fog emitted by a TIFA (Todd Insecticidal Fog Applicator) machine. This treatment resulted in good control of the high pine looper population.

Investigations on Semasia diniana Guen. were continued, the main interest being centred on the biology of the species and, particularly, on the host tree preferences exhibited by it. Further work on this topic will almost certainly be restricted by shortage of material since the population has "collapsed". Bacterial disease, predators, parasites, and intrinsic degeneration all seem to be involved in this reduction in numbers.

The biennial survey of larch sawfly numbers was again carried out, and in general low levels of population of the three main species *Pristiphora erichsoni* Htg., *P. laricis* Htg. and *Anoplonyx destructor* Bens. were recorded. Biological studies on the group of conifer sawflies were continued in the laboratory.

Experimental work on the insecticidal protection of young conifer crops against *Hylobius abietis* L. was completed during the year under review. Further observations and minor tests are being continued in user trials areas.

Two trials with "Swingfog", a light and portable insecticidal fog generator, were conducted during the year, one against *Semasia diniana* and the other against *Anoplonyx destructor*. Both gave disappointing results but further tests are being planned.

(Forestry Commission. Report on Forest Research for the Year ended March, 1958)

2. Forest Protection

An increase in the rabbit population is noted despite the continued prevalence of myxomatosis although at a much lower rate than in 1957. Hares also continued to increase particularly in the East Scotland Conservancy. The grey squirrel population (for once not the cause of very serious damage) remained more or less stable, whilst the plague of voles, troublesome in 1957, receded in 1958. Trees in 4 year old plantations of beech and Douglas fir in Hampshire forests were destroyed by brown rats. Electric fencing, tried out in a few Scottish forests to exclude deer from plantations met with a fair measure of success, but serious damage occurred in certain areas to the leading shoots of pine and larch by blackgame and to young conifers by blackgame and capercailzie.

Insect pests again gave relatively little trouble. The good growing season helped to clear up any possible ill-effects from the previous year's widespread infestations of *Neomyzaphis* (the green spruce aphis), which were not repeated in 1958.

The lack of sunshine and the continual rain favoured widespread fungal disorders, especially in the nurseries, where *Botrytis* and *Meria laricis* were particularly prevalent. The control of *Fomes annosus* in plantations, by stump treatment with creosote, was widely extended as standard practice during the year.

(39th Annual Report of the Forestry Commissioners for the year ended 30th September, 1958.)

WORLD HEALTH ORGANIZATION NEWS

Twelfth World Health Assembly

The Twelfth World Health Assembly, which was held from 12 to 29 May 1959, in Geneva, was attended by the delegates of 82 Member and Associate Member States, as well as representatives of the United Nations, specialized agencies, and inter-governmental and non-governmental organizations in official relations with WHO. Observers from several non-Member States were also present.

Malaria Eradication

The Director-General of WHO, Dr. M. G. Candau, referred in his report to the considerable progress made in the campaign against malaria: "Malaria has disappeared from regions of the globe whose population, totalling 300 millions, was previously exposed to the risk of this disease. In still other countries and territories with 700 million to 800 million inhabitants, eradication campaigns are being either already implemented or prepared. This means that of 1,300 million people, who, only a few years ago, were actual or potential victims of malaria, only 250 millions still remain unprotected by eradication measures."

Nevertheless, there could be no real progress towards the goal of eradication in any one country unless the conditions for success were established on a world basis, and it was the task of WHO to assist each country to provide these conditions. At the root of the idea of malaria eradication there was undoubtedly the danger of the development of anopheline resistance to insecticides. Ten species of anophelines had already acquired such resistance, and eradication should therefore be pursued rapidly and tenaciously."

The delegates of a number of countries gave details of progress in the fight against malaria. In Ceylon, for example, it was decided in 1957 to launch an eradication campaign which, it was estimated, would last for five years and cost 18 million rupees. The campaign was started in 1958, and it was now found that in view of changing conditions - increasing population, jungle clearance and the influx of people into newly developed areas - an additional 8 million rupees would be required to complete it successfully.

In the Belgian Congo, all urban centres and several large rural areas are already free from the malaria vector. The delegate of Greece stated that malaria has now been eliminated from one-third of the national territory. In India, the eradication programme is making good progress, and complete coverage of the country is in sight. It is anticipated that more than 12 million persons now exposed to malaria in Iran will be protected within the next few years. The campaign in Liberia is also making good progress, and the delegate of Liberia expressed the hope that his would be the first African country to eradicate the disease. In Peru, eradication has made rapid headway in the coastal areas, while complete eradication is expected in Venezuela within two years. The delegate of Spain stated that, between 1947 and 1958, the number of malaria cases in his country diminished from half a million to only 17. A number of delegates announced that eradication campaigns have recently been launched or are in the preparatory phase in their respective countries.

The delegates of India and Yugoslavia made an urgent plea for further contributions by governments to the Malaria Eradication Special Account, and the delegate of the German Federal Republic announced that his Government would continue to support the fund and intended to contribute a further $350,000 to it during the next two years. The delegate of Poland announced that his Government was prepared to make $80,000 worth of DDT powder available for the worldwide malaria eradication programme.

Bilharziasis

The delegate of the Sudan drew attention to an outstanding achievement in the field of bilharziasis control: the complete eradication of snail vectors of bilharziasis in the country's network of canals, totalling 8,000 km in length. Vigilant maintenance and supervision since eradication was achieved have kept the area - a densely populated one with thick vegetation - free from snails over a period of four years.

Difficulties were reported in the bilharziasis project in Iraq, mainly because of staffing problems; it was expected that the control and eradication of the disease would be complicated still further by the new land reform law which, although contributing immeasurably to the improvement of health and living standards in general, involves irrigation projects liable to cause an increase in the incidence of bilharziasis. The delegate of South Africa mentioned that such an increase has occurred as the result of irrigation schemes in those areas of South Africa which, formerly malarious, are now being opened up for agricultural development. In Ghana, it is feared that the disease may also spread as development plans are put into operation.

The United Kingdom delegate observed that, while much is already known about the parasite that causes bilharziasis, as well as about control measures, not so much attention is paid to its effect on the community. He illustrated this statement by taking the case of an area in Uganda where some 100,000 people are infected: in the children there is much anaemia and enlargement of the spleen, yet after the age of 20 the infection seems to disappear. Moreover, the type of infection varies so much from area to area that indiscriminate treatment of all infected people may not be the best means of control but may destroy immunity naturally built up in certain areas.

The filariases

The delegate of France called for intensified research on, and control of, onchocerciasis in Africa and filarial infections in the Pacific, suggesting that WHO send experts to the affected areas to help the health authorities with mass control campaigns. The delegate of Ghana said that onchocerciasis was a disease of serious public health importance in his country, where a medical field unit has for some time been seeking solutions to the problems involved in its control. A WHO-assisted study of blindness due to onchocerciasis, and ways of preventing it, has been undertaken in the Sudan; this problem is also a source of grave concern to the Nigerian health authorities. The delegate of Sierra Leone hoped that it would shortly be possible to proceed with the control and eradication of onchocerciasis in his country, where some of the earliest and most important research on the disease was carried out. Onchocerciasis has recently been discovered in Venezuela, and the incidence appears to be high in those areas where it has so far been found, although ocular lesions seem to be less frequent and less serious than in other countries. The disease has also been reported recently in Aden and the Yemen.

The delegate of Ceylon spoke of the problem of endemic filariasis in the western part of his country. The economic losses due to the disease are serious, since two of the country's most important sources of revenue - coconut plantations and the fishing industry - are centred in the endemic area. In India, a nation-wide programme of filariasis control has been started.

The delegate of Italy suggested that certain arthropod-borne diseases, such as filariasis and leishmaniasis, should receive more attention from WHO. Supporting this suggestion, the delegate of Indonesia stated that filariasis is endemic in various parts of his country, where a shortage of trained personnel makes it difficult to give the disease the attention it needs. It was his opinion that WHO could foster and encourage at least the beginning of research on the epidemiology, treatment and prevention of filariasis in Indonesia and elsewhere.

Environmental sanitation

A number of delegates mentioned the serious health problems arising from inadequate environmental sanitation in their respective countries. In Ceylon, for example, one out of every seven hospital patients and one out of every five out-patients at dispensaries suffer from parasitic or water-borne diseases, while the absence of any form of water supply in certain parts of the Sudan means that many of the inhabitants are nomads wandering from one source of water to another. The Iranian delegate stated that the main concern in his country, and presumably in a number of others, is the provision not only of pure drinking-water but of adequate water supplies to every community.

In Portugal, where 96% of the towns and cities now have supplies of pure drinking-water, a special effort is being made to extend these supplies to all villages with more than 100 inhabitants; a parallel effort is being made in Portuguese territories overseas.

In India, an extensive programme is now in operation for the provision of pure water supplies in both urban and rural areas, and the delegate of India suggested that a full and exhaustive survey of water requirements should be made in each country with a view to evolving a systematic plan for supplying them within a measurable period of time. He added that, while WHO could not be expected to make substantial financial contributions in this connexion, owing to its limited budget, its technical aid would be invaluable. The United States delegate also stressed the importance of potable water supplies and stated that the President of the United States had asked Congress to make funds available for WHO's programme in this field. The delegate of Morocco considered that the problem of sewage disposal, as well as that of water supplies, should be given special attention.

(W.H.O. Chronicle, July-August, 1959, 13, (7/8).

Control of plague vectors

Up to the present time no effective resistance to insecticides has been noted in the insect species involved in the propagation of plague. In general, DDT dusting is extremely effective against fleas, and the method of patch dusting, in accordance with standards laid down by the Expert Committee on Insecticides,* is especially to be recommended on account of its efficacy and cheapness and the ease with which it can be applied. A 10% powder should be used against the less sensitive ectoparasites, and very good results have also been obtained with 1.5% dieldrin and 2% aldrin dusting powders.

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* Wld.Hlth.Org.Techn.Rep.Ser., 1958, No. 153, p.42.

Diethyltoluamide, undecylenic acid, propylacetanilide and benzyl benzoate are good flea repellents for use on clothing.

(W.H.O. Chronicle, 1959, 13, (5), 224).

PEST CONTROL RESEARCH IN THE U.S.A.

1. Mosquito Control

Cooperative studies by the Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, and other agencies in Delaware and New Jersey, from 1953 to 1955 showed the value of controlled flooding as a means of mosquito abatement in some areas. Under this system, the production of salt-marsh mosquitoes was virtually halted by preventing the exposure of soil upon which the pests lay their eggs. At the same time, waterfowl conditions were greatly improved. This method is now being used in suitable situations in Florida for the control of mosquitoes.

Recently (April 1959) a symposium was held in the Department of the Interior Building, Washington D.C. with a view to co-ordinating mosquito control and wildlife management objectives. The symposium, the first of its kind, was sponsored jointly by the American Mosquito Control Association, the Bureau of Sport Fisheries and Wildlife, the Wildlife Society, the Agricultural Research Service of the U.S. Department of Agriculture, and the United States Public Health Service.

Papers on the first day were restricted to the fundamentals of mosquito biology and control and to the fundamentals of wetland management for fish and wildlife. Papers on the second day included reviews of methods of mosquito control by chemicals and by water management, their effects on various types of fish and wildlife, and the effects of fish and wildlife water-development projects on mosquito breeding.

Proceedings of the meeting will be available at $ 1 a copy through the American Mosquito Control Association, Morris Plains, N.J., U.S.A.

(Commercial Fisheries Review, 1959, 21, (6), 54.)

2. How a Mosquito Repellent Works

Recent studies have been made on diethyltoluamide containing radioactive tracers. For testing the mosquitoes' reactions to repellents, an improved method of offering food was developed. Instead of the human arm a glass cylinder holding blood covered by a membrane was used.

Repellent was spread on the membrane or emulsified into the blood. Counts of activity of the insects' probosces and feet showed whether they had been in contact with the membrane.

Work with tracers bears out field observations. Mosquitoes keep off and hover a short distance above skin freshly coated with repellent of adequate strength. As the repellent loses strength - or if a weaker concentration is used - the insects begin to land but leave immediately. Then more and more mosquitoes land and remain on the skin, walking about or standing but not attempting to probe. Later, they touch their probosces on the skin as though about to bite without actually doing so, probably because the vapour close to the chemical source is still strong enough to repel them. They may make such contacts in several places and they frequently stop and rub the probosces with the feet as though to clean it. Eventually they begin to bite. In cases where they insert their probosces but do not take blood, the mosquitoes may be repelled by the chemical coming in contact with sensory organs of the mouth parts.

The repellent was also tried as a systemic by injecting it into rabbits and exposing them to mosquitoes. Practically all insects fed on the rabbits, showing that they had not been made repellent. Blood from other rabbits injected with the repellent was offered to mosquitoes More than 90% of the mosquitoes fed on the blood. These results indicate that an animal's body destroys or removes diethyltoluamide from the blood almost as fast as it is introduced.

Radioactive tracers were also used to study the fate of diethyltoluamide applied to skin of guinea-pigs. Six hours after treatment, all guinea-pigs had lost about the same amount of chemical by evaporation. The amount not accounted for by evaporation or rinsing from the skin was assumed to be absorbed into the animal's body. Most of the absorbed chemical was excreted in the urine. The peak of radioactivity in the urine occurred within 12 hours, and over 80% of the absorbed dose was excreted in 24 hours, 89% in 48 hours, and 93 to 95% in 216 hours. Only about 0.75% was recovered from the faeces. Some radioactivity was found in the hair that grew out of the treated skin. These findings agree with those from earlier work using non-radioactive diethyltoluamide on humans.

(Agricultural Research, July 1959, 8, (1), 8-9.)

3. Shark Repellent

The Office of Naval Research recently awarded a research contract to the East Boston Fishery Technological Laboratory. This work, to be done in Boston, will include chemical studies on decomposing shark meat with the eventual aim of finding an effective shark repellent. Shark meat will be decomposed under various conditions. The resulting product will be extracted, concentrated, and an attempt made to isolate and identify the active material. The biological testing of the effectiveness of the resulting products will be done by the Navy who will maintain close contact with Bureau technologists.

(Commercial Fisheries Review, 1959, 21, (6), 27.)

4a. Better Traps Aid Pest Sampling and Control

In the general programme for improving cotton insect control Agricultural Research Service scientists are experimenting with fine bands of ultra-violet light with a view to attracting a wide range of insects, and with "fine-tuning" techniques for attracting single species only. Thus, far, however, they have found no wave length that attracts the boll weevil although the adult pink bollworm and cotton bollworm moths are attracted by the near-ultraviolet range.

Ultraviolet light is already used to attract insects and reveal just how many pests there are in the area and the time of emergence. The light provided by a 400-watt mercury vapour lamp is being used as an attractant for both electrified grid traps and the new suction fan traps that collect insects in a mesh bag.

4b. Treatment of infested grain with radio waves

Heat from radio-frequency electric fields kills in seconds rice and granary weevils, flour beetles, dermestid beetles, and lesser grain borers in stored wheat and wheat shorts.

In research by USDA and the Kansas and Nebraska Agricultural Experiment Stations, wheat was given brief exposures to radio frequencies of 10 to 39 megacycles per second and field intensities of 1.2 to 3.6 kilovolts per inch. The resultant temperatures of 140° to 150° F. required to kill the above insects did not damage the wheat; to kill other insects that infest our stored grain, however, might take higher temperatures.

This method has not yet been used in industry because of high cost. The present experimental unit, adapted from components available on the market, has a low capacity of 400 bushels per hour. Cost of large-scale treatment is estimated at $3\frac{1}{2}$ cents a bushel - far more than fumigation costs. A commercially practical adaptation of the method is being sought, by the researchers.

(Agricultural Research, August, 1959, 8, (2), 9).

5a. Rice Water Weevil

Young rice plants damaged by the rice water weevil - *Lissorhoptrus oryzophilus* Kuschel - were found in fields near Biggs on June 1, 1959. The weevil is widely distributed in the rice growing states of the south, and ranges through the Atlantic states into Canada feeding on grasses in swampy areas. Judging from the abundance of the weevil at the Rice Experiment Station and in an adjacent field it is assumed that the pest was introduced prior to 1959, although the June discovery apparently is the first record of the weevil in California.

Texas investigations have demonstrated the value of seed treatments with lindane, aldrin, and dieldrin. In experimental plots four to eight ounces of toxicant per 100 pounds of seed gave 90% control - and dieldrin at one ounce per 100 pounds gave an 80%-90% reduction of larvae in a field trial. The mode of action of seed treatments in controlling the rice water weevil is unknown.

5b. Corn Earworm Control

Excellent control of the corn earworm, *Heliothis zea* in grain sorghum (RS610 variety) was obtained with DDT spray and dust - each 98.8% - followed closely by Phosdrin - 97.1% and Thiodan - 95%. Guthion with 84.9% and Dylox with 89.1% gave the poorest control.

To achieve maximum control, fields should be treated while the larvae are small and before extensive feeding damage has occurred in the heads.

(California Agriculture, August 1959, 13, (8), 10.)

6. Integrated Control Measures

"A test plot was established in April 1954, to determine if control of the heavy infestation of the Argentine ant, *Iridomyrmex humilis* Mayr, present in the grove would improve biological control of the red scale which, presumably, had been distrubed by the ants.

Field counts and laboratory samples taken during 1954 showed a relatively high red scale density coupled with a comparatively low percent parasitization by the naturally present parasite, *Aphytis chrysompha*

Mercet. The dense population of the ant seriously inhibited the activity of parasites and predators of the scale. Chemicals used to control ants are applied to the ground and, therefore, do not affect natural enemies of the red scale on the trees. Late in 1954 ant control was sufficient for the colonization of the scale parasite, A. linganensis.

In January 1955, five check trees of similar red scale densities were selected for periodic counts of the parasite and scale populations. By August, the red scale infestation had decreased markedly and was under satisfactory biological control. At the end of the pre-treatment period, January-August, the red scale density index rating was three per tree-sample, with an average of 19.3% parasitization by Aphytis which, in general, is sufficient to effect good biological control. The red scale and parasite populations were more or less uniform throughout the test area, and all pests except mites were under good biological control. This situation appeared satisfactory for initiating tests of miticides to evaluate their effects on biological control of red scale.

The initial six-acre plot was sub-divided into four plots, each of which received chlorobenzilate for the control of citrus bud mite plus one other miticide for the control of citrus red mite. Earlier field tests in other plots have demonstrated that chlorobenzilate has no measurable detrimental effect on the parasites and predators of citrus insects.

Spray treatments were applied only as mite increases dictated, the first in August 1955, the second in April 1957, the third in September 1957, and the fourth in April 1958. The combinations of materials used are listed in Table I except that in plot No. 1 no Tedion was used in the 1955 spray. Final scale population counts were made in December 1958.

Table I

Chemical Mite Control Treatments Tested

Plot No.	Materials applied		Application/ 100 gal./water
1	(Chlorobenzilate	25% EC [b]	1 pt.
	(Tedion [a]	25% WP [c]	1 lb.
2	(Chlorobenzilate	25% EC	1 pt.
	(Kelthane	18.5% EC	1½ pt.
3	(Chlorobenzilate	25% EC	1 pt.
	(Delnav	25% EC	1½ pt
4	(Chlorobenzilate	25% EC	1 pt.
	(Trithion	50% EC	12 oz.

[a] Not incorporated in the first spray application.

[b] EC - emulsifiable concentrate.

[c] WP - wettable powder.

Table II

Effect of Four Applications of Miticides During a Three-Year Period on Average Population Density of California Red Scale and Average Parasitization by *Aphytis*. ∅

	Populations				
	Pre-treatment Aug. 1955 Av./grove	Post-treatment Dec. 1958 Plot			
		1	2	3	4
Density rating	3.0	3.8	5.5	10.3	4.4
Parasitization ∅	19%	29%	26%	19%	15%

∅ Percent parasitization, as used here, does not depict total parasite-caused mortality, as the scale mortality caused by adult parasites feeding on the scale body fluids is not included. In general, an average parasitization of 20% by *Aphytis* will effect good biological control.

Table II shows the average red scale density and the average percent parasitization before and after the three-year treatment period. Throughout the treatment period there was no significant change in host-parasite trends following each successive spraying, and the average red scale density of all plots remained well below the economic threshold of 20 scales per tree-sample as based on the index rating, although the plot 3 - Delnav - rating was higher than might be desired. The percent parasitization in each plot also compared favourably with that prior to treatment, indicating that, at the dosages used, none of the materials tested were of sufficient toxicity to upset appreciably the biological control program in this grove. However, plot 3, with the highest scale density, did not exhibit a correspondingly higher degree of parasitization, and parasitization in plot 4 - Trithion - was somewhat low as compared to plots 1 and 2. Plot 1 - chlorobenzilate and Tedion - was the best.

The experiment also re-affirmed that efficient ant control is essential in maintaining a satisfactory degree of biological control of California red scale and that biological control can be greatly enhanced if selective insecticides only are used, to avoid upsetting the parasite-host relationship."

(P. DeBach, J. Landi and L. Jeppson. California Agriculture, 1959, 13, (7), 12.).

7. Strip-treatment with chemicals

Based on results of an eight-year study, a 12-month alternation strip-treatment seems to be a feasible control programme throughout Orange County areas where purple scale - *Lepidosaphes beckii* (Newm.) - is the primary pest on oranges.

The oriental purple scale parasite - *Aphytis lepidosaphes* Comp. - does not produce completely satisfactory biological control of the purple scale, but it does substantially retard the rate of increase. Therefore, chemical control treatments must be used.

In citrus, as in most crops - after major and repeated applications of insecticides over long periods of time - it is necessary to determine whether the maximum conservation of natural enemies of citrus pests is obtained. Such a determination involves a study of what happens when no pesticides are applied. The study is limited to small test plots that must be observed for a period long enough to attain an adequate balance between the pests and natural enemies. All pests normally treated with insecticides may not be as bad as previously thought because certain capable natural enemies of one pest may have been suppressed by treatment for another pest. In the case of citrus, ants must be controlled to obtain maximum natural enemy effectiveness. However, ant-control chemicals are put on the ground - not the trees - and do not interfere with natural enemies on the trees.

Investigations of this nature were carried out in various untreated study plots on Valencia orange trees in Orange County beginning in 1948. During the next few years these studies showed that most so-called pests were not so serious as might have been indicated by observations made in some regularly treated orange groves.

The principal exception was the purple scale which lacked effective natural enemies and usually became serious in the absence of chemical treatment.

If purple scale could be controlled by use of an insecticide that would not appreciably upset the natural enemies of the other pests present, an over-all pest control programme might be improved and costs reduced.

Several possibilities for the development of an integrated chemical-biological control programme in orange groves were considered. All were based on the concept of leaving unharmed in a grove an adequate reservoir of natural enemies of the entire faunal complex while controlling the purple scale chemically. The most practical possibility seemed to be periodic strip-treatment applied on a predetermined schedule of spraying or skipping alternate tree rows or pairs of rows. By using such a pattern, untreated reservoirs of natural enemies would always be left in a grove.

Two trial plots of approximately 10 acres each were established in Valencia groves in Orange County. Each plot was divided systematically on a map into alternate pairs of rows which would be treated at six-month intervals - spring and fall - with oil spray. This would always leave an untreated row next to a treated row, so that natural enemies could rapidly reinoculate the treated rows.

Oil spray was chosen for testing in this programme because it leaves no long-term toxic residue, its drift-effect on natural enemies is not great, and it has proven satisfactory in controlling purple scale in the area. It was assumed that an oil spray would give satisfactory control of purple scale for a period no longer than 18 months.

To evaluate the control obtained from the strip-treatment pattern of spraying, purple scale population density surveys were made each spring and fall prior to treatment. The surveys were based on a careful examination and rating of each tree in the two test plots. In addition, monthly observations and ratings were recorded denoting the effects, if any, of the staggered, alternate-row treatments on the purple scale-parasite relationship. Other pests in the groves were rated also to determine whether or not those pests with effective natural enemies were upset by the programme. The test plots were visually compared periodically with adjacent plots receiving more or less standard over-all spray treatments.

In both test groves purple scale and citrus red mite were the most serious pests during the years before the studies were started. Other pests - which are or have been serious problems on citrus in some districts and are potential pests in this area - including the California red scale, black scale, soft brown scale, cottony-cushion scale, citrus aphids, orange worms, and mealybugs were present in the test groves. During the 1951-55 study period these insects were usually held in check by natural enemies.

By the fall of 1955 it was evident that these strip-treatment trials were successful. Purple scale had remained under good commercial control for the four-year test period, and populations of various potential pests showed no significant increases or differences that could be correlated with the use of strip-treatment. Citrus red mite populations were generally lower than in adjacent regularly treated areas, and mealybugs were less evident throughout the groves than pre-test surveys had indicated. The natural enemies of the California red and black scales were common throughout both plots and proved to be effective in maintaining a satisfactory degree of biological control.

Information accumulated during 1951-55 indicated modification of the strip-treatment schedule would improve the control programme.

The desirability of modification hinged on the findings of other researchers that spring oil-spray treatments on Valencias in Orange County may be detrimental to fruit quality and production. Also, it proved difficult to maintain and coordinate a programme of treating alternate pairs of rows at six-month intervals. Financial savings to the grower could be improved because - even though one-third less spray material was applied per year - the pest-control operator had to go through the grove twice a year.

Furthermore, it was now known that purple scale could go untreated for a full 18 months under a strip-treatment programme; the purple scale parasite had become established during the 1951-55 test period and was slowing down the rate of purple scale increase in Orange County. Therefore, a 24-month period between treatments might be feasible under strip-treatment, which would mean treatment of every other pair of rows once a year - only one-half the grove - in the fall. Pest-control costs would be reduced by at least 50% and the spring oil spray treatments eliminated.

Early in 1956 a modified programme was initiated for the same Valencia test plots used in the first trials. The spring oil treatment was omitted and each fall every other pair of tree rows were to be treated. Each successive year the rows untreated the year before would be treated. A third 10-acre test plot near Irvine was established under the new modified programme early in 1956.

In the process of converting the original strip-treatment plots from a six-month to a 12-month alternation programme, certain rows had to go untreated for a longer time than would have occurred on the original schedule. In one plot a considerable citrus red mite attack occurred in those particular rows the first season. Barring that one incident, the two original alternate strip-treatment plots continued under satisfactory commercial control of all pests under the 12-month alternation programme until April 1959 when the test was terminated. The new plot near Irvine had received a regular annual treatments and had a heavy black-scale infestation. There was evidence of previous citrus red mite damage and all the usual insect species were present. Under the 12-month alternation strip-treatment programme the black-scale infestation decreased satisfactorily within one year and all other pests remained under good commercial control until April 1959.

The purple scale parasite accounted for considerable mortality through parasitization and host-feeding on scale in the untreated rows as well as on scale that may have survived in the treated rows. Thus the parasite was instrumental in the success of the strip-treatment programme. Other potential pests in the groves studied were held in check by effective natural control factors, primarily parasites and predators.

(California Agriculture, August, 1959, 13, (8), 14-15.)

STUDIES RELEVANT TO THE CONTROL OF PESTS
SCIENTIFIC RESEARCH IN BRITISH UNIVERSITIES 1958-59

Details are substantially the same as those given in the previous list (see P.A.N.S. 'A', 1959, 5, (3), 299-302.) An additional entry from Durham University is noted:

DURHAM UNIVERSITY, KING'S COLLEGE, NEWCASTLE-UPON-TYNE

Department of Agricultural Entomology

Dr. G. Heslop-Harrison A. Ibbotson	Disease transmission, world distribution, evolution, phylogeny and fossil history of the jumping plant-lice (Homoptera: family Psyllidae.) The ancestry and evolution of the Insecta, with special reference to their fossil record. The ecology and bionomics of grassland insects with special reference to the frit fly and its relatives.
Dr. A. Milne R. Laughlin	Biology and ecology (particularly population problems) and physiology of selected agricultural pests, e.g. sheep tick (*Ixodes ricinus* L.), garden chafer (*Phyllopertha horticola* L.) leather-jacket (*Tipula oleracea* group), and swede midge (*Contarinia nasturtii* Kieffer.)

NEWS ITEMS FROM THE COMMONWEALTH

AUSTRALIA - NEW SOUTH WALES

Fruit Pests

Citrus red scale, Aonidiella aurantii: The development of spray schedules including malathion in combination with low concentration oil sprays has yielded confident recommendations for late season spraying where normal oil sprays would be risky to use.

The inclusion of half strength white oil with organo-phosphorus insecticides increased their effectiveness; but such combinations, e.g. white oil and Trithion, can cause fruit marking. Gusathion or Tetram without the addition of white oil spray was not promising. There was little to choose between a so-called "superior" oil and a standard white oil when applied at similar dilution rate.

White wax scale, Ceroplastes destructor: Experimental work again confirmed excellent control with well timed and thoroughly applied white oil sprays, whilst a combination of Gusathion and white oil at half strength gave very good results.

In a comparison of two methods of spray application using a "drive past" technique, very much improved control was obtained where inside and outside spraying were practised as compared with outside spraying alone. This was particularly so where trees were originally more heavily infested. It further emphasises that most of the unsatisfactory results reported by growers following the use of recommended materials are due to poor spraying.

Systemic insecticides Systox and Pestox showed some promise when applied whilst the young scales were on the leaves, and their further investigation is warranted.

White louse scale, Unaspis citri: Colloidal or dispersible sulphurs used in combination with routine, "petal fall" copper fungicide sprays in spring continued to prove useful. Growers in general have welcomed this recommendation.

Tests of malathion in combination with Bordeaux mixture have shown this combination to be ineffective for control of white louse scale, but when used in combination with neutral copper fungicides under similar conditions malathion has given very good control.

Soft brown scale, Coccus hesperidum: Timed applications of full strength white oil or combinations of half strength white oil and malathion showed satisfactory control of this scale. Where ants were controlled, by trunk and ground spraying with dieldrin, results from all materials were markedly improved.

Light brown apple moth, Tortrix postvittana: Seasonal conditions were quite unfavourable to this pest. No trouble was experienced until the late summer when some damage was noted in late apples. In codling moth control experiments it was noted that the organo-phosphorus insecticides Gusathion and diazinon effectively controlled this pest but Trithion had little effect.

Codling Moth, Cydia pomonella: Weather in the spring and summer particularly favoured this pest. It was very active, State-wide. Windy spring weather made spraying difficult, and the high temperatures probably reduced the efficiency of DDT sprays. In many orchards the results with DDT were so unsatisfactory that growers sought other insecticides.

Gusathion in a three-weekly spray schedule gave best control of any material tested; whilst Trithion and diazinon in a similar programme also gave good control of fruit entries, although noticeable stinging in the diazinon treated plots indicated that the interval between sprays was too long.

Red spider, Tetranychus urticae: Experimental work at Orange indicated excellent control by Kelthane and Meta-systox applied in mid-January when rapid build-up was commencing. They kept trees free of infestation for 5-8 weeks. Then predator activity by Stethorus ladybirds eliminated any need for further sprays.

Malathion, as an emulsion or as wettable powder, applied twice, with an interval of twelve days between sprays, gave inferior protection.

When applied in a three-weekly schedule for codling moth control, Gusathion, Trithion and WCI gave complete control of spider whilst malathion in a seasonal programme of 12-14 day intervals was satisfactory. In an orchard at Orange with a history of organo-phosphorus spraying, red spider resistance to this group of materials was observed in a block of Delicious apple trees.

Red mite, Bryobia praetiosa: In experiments at Orange "superior oil" 1/100 plus lime-sulphur 1/20, or "superior oil" alone at 3/100, applied at green tip, gave excellent control until new year. Metasystox, applied alone, in early November, gave very good control for the remainder of the season. Growing-season sprays of Kelthane or Trithion gave complete control for the remainder of the season as did one application of HETP plus PCPPBS or Chlorocide. Malathion in a seasonal programme at 14-day intervals gave good control but was not effective when used as isolated applications.

Banana beetle borer, Cosmopolites sordidus: In a long-term experiment at Condong, which will proceed until evidence of insecticidal breakdown, it has been demonstrated to date that (a) dieldrin ½ lb. per acre quickly reduces high populations of Cosmopolites and is effective for a prolonged period; (b) low and high volume dieldrin ground and butt sprays are equally effective; (c) total ground sprays of dieldrin (e.g., as included in weed control sprays) give similar results to butt sprays; (d) both aldrin and dieldrin high volume butt sprays, at rates of 2 lb. per acre and 1 lb. per acre respectively, remain effective for at least eighteen months.

In an experiment at Clothiers Creek to evaluate combined control of beetle borer and rust thrips, dieldrin and aldrin effectiveness against Cosmopolites were again demonstrated. Aldrin at 17 oz. per acre, and dieldrin at 5 oz. per acre, as ground and butt treatments, gave very good results. Both dieldrin dust and diazinon spray reduced Cosmopolites but not sufficiently to warrant their use, especially diazinon.

Vegetable Pests

Red spider, Tetranychus spp.: Spraying trials at Gosford showed that Phenkaptone and Trithion were outstanding as miticides for bean crops. Their protective effect withstood conditions favouring severe infestation and re-infestation. Avoidance of infestation by good cultural practices and prompt disposal of spent crop residues was seen to be the most important practice.

Cabbage white butterfly, Pieris rapae: Spraying trials at Gosford showed satisfactory control under moderate intensity of infestation by either diazinon or a combined spray of DDT + malathion applied weekly over the tops of the plants.

Stores Products Pests

Wheat weevil, Calandra granaria and C. oryzae: No ill-effects on germination immediately followed the fumigation of Festival wheat having a moisture content of 11 per cent., when Phostoxin tablets were used at the standard rate of 5 tablets per 40 bushels, and at twice that dosage. In a small-scale trial the inadequacy of using Phostoxin tablets under less than gas-tight conditions was again demonstrated. Heavily infested wheat treated at the rate of one tablet per bushel bag for five days under a tarpaulin showed a complete kill of Tribolium sp., a 98 per cent. kill of Calandra oryzae (small strain), and 99 per cent. kill of Rhizopertha dominica adults.

Ephestia spp.: For stored cocoa beans, pyrethrum sprays applied weekly at change of light (mainly dusk) have been of value with low populations, and fumigation is often needed shortly after arrival from West Indies and West Africa.

(Department of Agriculture, New South Wales, Annual Report, 1958.)

AUSTRALIA - SOUTH

Forestry: It is reported that a minor outbreak of Ips grandicollis was controlled by barrier spraying of benzene hexachloride, and the removal and burning of the affected trees, which were seven years of age.

An inspection of damage to pines by cockatoos revealed the presence of larvae of the longicorn in dead wood on the damaged side of living trees. The insect was also present in the heartwood of live trees.

(Annual Report on the operations of the Woods and Forests Department for the year 1956-1957, South Australia.)

AUSTRALIA - VICTORIA

Rabbit Control by Aerial Baiting: The method consists of broadcasting baits over a rabbit infested area from a low-flying aircraft. Minor modifications to the hopper of a plane used for aerial agricultural work enable bait to be distributed. The main difference between aerial and ground poisoning methods for rabbits is that, with aerial poisoning, baits are broadcast over feeding grounds instead of being laid in a furrow or trail, and generally a greater density of bait is used on a given area. The same bait materials are used as in ground poisoning ("1080"), and free feeding is carried out if required. In the aerial poisoning work already done in Victoria, carrots have been the best bait material. Free feeding has been always carried out, not on consecutive days, but at intervals of several days, and sometimes a week. This longer period between free feeds was found to be effective and it became standard practice to spread free feed every 5 to 7 days. In some experimental poisonings without free feeding the results were poor.

(G.W. Douglas. J. Agric., 1959, 57, Pt.3, 145-158.)

AUSTRALIA - WESTERN

Citrus Red Scale Control

Two standard control methods are employed against the red scale, namely, spraying and cyanide fumigation.

Sprays

White Oil: The most generally used control in this State (Western Australia) is white oil applied in the late summer at a strength of 1 part of oil to 40 parts of water (2½ gal. per 100 gal. of water or 1 pint to 5 gal.) Where bad infestations of scale need controlling, two sprays will be found more effective than one. The oil concentration should be halved however (i.e. 1 part to 80 parts of water) and the first spray should be applied in December and the second one about March.

Malathion: Malathion has been found effective against red scale and is recommended at a concentration of 0.1% to 0.2% depending on the severity of the infestation (1½ to 3¼ pints of 50% malathion concentrate to 100 gal. of water). Investigations overseas and in the Eastern States suggest that malathion wettable powders may be more effective than malathion emulsions, but no comparative tests have been done locally. The wettable powder concentrations suggested are 3 lb. of 25% powder to 100 gal. of water.

Malathion - White Oil Combination: A mixture of white oil and malathion will be found useful against both red scale and the citrus white fly. The combination suggested is:

White Oil - 1¼ gal.
Malathion 50% - 1 pint
Water - 100 gal.

Parathion: Parathion has been used effectively against red scale but in some instances it has led to an increase in soft brown scale. Malathion has not had this undesirable effect, and in view of its lower toxicity to humans, malathion is recommended in preference to parathion.

Care of Application: In applying oil and other sprays it is essential to use high pressure equipment. The insecticides depend upon contact for their efficiency and so must reach the centre of the tree and the under surface of the leaves. Spraying should not be done during a heat wave or when trees are stressing for want of water, otherwise foliage injury may result.

Fumigation

Hydrocyanic acid gas is probably the most universally used agent for scale control, although in Western Australia it is now seldom used.

(C.F.H. Jenkins. J.Agric.Western Australia, March-April, 1959, 8, (Third series), No.2, 171-177.)

INDIA

Coconut Pest Control: "Trials at the Central Coconut Research Station, Kayangulam have shown that by far the best method of controlling the rhinoceros beetle is to destroy the beetle grubs in their breeding places like manure pits by spraying them every two or three months with 0.1% water dispersible BHC. The black-headed caterpillar can be kept in check by spraying the leaves of the coconut palm with a 0.2% solution of water dispersible DDT once in two months till the attack subsides and the red palm weevil could be destroyed by injecting into the affected part of the palm Pyrocone E (Pyrethrins/piperonyl butoxide). It has also been shown that the larvae of the cockchafer could successfully be controlled by ploughing into the soil 5% BHC dust at the rate of 56 lb. per acre, once during August or September and again in March or early April".

(The Indian Central Coconut Committee. Thirteenth Annual Report, 1st April 1957 to 31st March 1958.)

Coffee

Stem Borer, Xylotrechus quadripes, Control: Several field trials with insecticides are reported. In one of these BHC W.P. and emulsion formulations have given consistently good control compared with BHC dust and parathion (Folidol) emulsion. In another trial in which BHC, chlordane and dieldrin formulations were compared at varying concentrations, the data indicate that dieldrin was the best insecticide, particularly 'Dieldrex' E.C. at 0.25% applied thrice per year. Other trials are being made with heptachlor and Gusathion. The use of a sticker with BHC, dieldrin, heptachlor and Gusathion is also being investigated.

Green Bug, Lecanium viride, Control: Trials with the systemic organo-phosphorus compounds - Metasystox and Ekatin, are being made. The insecticides are being applied to the plants by a 'banding technique' where a piece of absorbent cotton, 3-4 in. wide is wound round the main stem of the plant enclosing an alkathene cone into which known quantities of insecticidal solution are poured. After 2 weeks the bands are removed.

In the preliminary trials, with one of the products - Metasystox - 60 to 90% mortality of the bugs was observed when 20 to 30 ml. of 1 and 1.5% concentration of the actual ingredient was applied to 2 - 3 year old arabica plants. In the extended trials with the same product and also with Ekatin, on different age group of plants above ten years, the results were, however, not promising. This failure may perhaps be attributed to the concentration and dosage used which may be inadequate to bring about the lethal effects to the same degree, as above, on fully grown bushes. Presence of entomogenous fungi on the green bug also interfered in the proper assessment of the efficacy of the insecticides. The trials are to be taken up further next year.

Hemileia vastatrix Control: The experiment started in June 1957 to find if spraying with Bordeaux mixture at strengths lower than the standard 0.5% could give efficient control of coffee leaf disease has now concluded. The results indicate that the use of concentrations lower than 0.5% is not advisable.

(Tenth Annual Report of the Research Department of the Coffee Board, 1956-1957. Research Department Bull.No.10.)

Tea

Mites: Control is generally achieved by the use of wettable sulphur formulations and of Akar 338. The tolerance limit for the latter in tea has not been fixed yet, though, based on residue analysis figures, it seems probable that 5 p.p.m. will be accepted as the limit.

Blister blight: (V. Jayaraman and C.S. Venkata Ram): In 1958 trials of nine copper fungicides with 50% copper content as either oxide (Perenox) or oxychloride (Bayer 4848, Blitox '50' and Microcop) gave satisfactory protection throughout when applied at the rate of 6 oz. to the acre. At the same rate of application fungicides containing 45% metallic copper (Coppesan and Cobredon) also gave comparable results. Colloidal copper containing 21% metallic copper gave statistically the same disease control as the standard (50% copper oxide) fungicide, at 6 oz. Experimental Fungicide 7 and Omicron '24' containing 25% and 24% copper, respectively, as oxychloride, were significantly less efficient than the standard fungicide at 6 oz. per acre. However, at 12 oz. Omicron '24' gave protection comparable to that in the standard fungicide treatment. At half the normal rate of copper applied per acre (3 oz. of 50% copper fungicide), Perenox gave adequate protection throughout. Experimental Fungicide 7 and Omicron '24' gave significantly better disease control than Blitox '50' but less than that achieved with Perenox.

(Annual Administration Report, United Planters' Association of Southern India, Scientific Dept., (Tea Section) for 1958-1959.)

NEW ZEALAND

Apple - Powdery Mildew: Powdery mildew caused by the fungus *Podosphaera leucotricha*, is a serious disease of apple orchards in New Zealand. Though prevalent throughout the country, it causes the greatest damage in the fruit-growing districts of Marlborough, Canterbury and Central Otago. Where control measures are neglected the injury caused by this fungus to foliage, shoots, leaf and blossom buds, and fruit of susceptible varieties weakens the trees and seriously reduces the quantity and quality of the crop.

The author describes its symptoms, cause and economic importance and control by pruning and spraying. Two spraying schedules are given. One is based on lime sulphur/colloidal sulphur for severe infections of varieties susceptible to mildew and black spot. The other, incorporating "Sulfane" and "Karathane" is recommended for varieties heavily infected with mildew but less susceptible to black spot.

(C.E. Woodhead. New Zealand Journal of Agriculture, July 1959, 99, (1), 53.)

Bird and Slug Repellent: The commercial fungicide thiram has been used overseas as a bird repellent, the method being to wet the seed in an asphalt emulsion containing one part of asphalt to three parts of water and then to coat the seed with powder containing one half of thiram and one half of an inert ingredient.

Preliminary tests have been carried out at the Department of Agriculture's Rukuhia Soil Research Station on this use of thiram as a bird and slug repellent on seeds. The method used was to make the seed just sticky with rubber solution diluted with an equal quantity of white spirit and to mix the commercial thiram powder with the seed until it was dry and free running. The mixing could be conveniently done in a concrete mixer. The seed was then aired for a few hours before being bagged. A quarter pint of diluted rubber solution was adequate for 10 to 15 lb. of large seed such as maize, peas, or wheat, and thiram powder equal to one tenth of the weight of the seed was used. This is probably more than necessary.

After sparrows had been fed on barley and peas until a flock was in regular attendance, small areas of barley and peas, both treated and untreated with thiram, were sown. The untreated seed was completely removed, while the treated seed was apparently untouched and germinated well.

Two small bare areas adjacent to long grass were oversown with treated and untreated subterranean clover. Slugs destroyed most of the untreated seed, but no damage could be observed on the treated area until well after all seed had germinated, when heavy frost lift destroyed the trial.

Thiram is probably injurious to inoculants, but slug damage is such a big factor in the success of oversowing that where inoculation may not be critical thiram as a slug repellent is well worth a trial.

(T.F. Southon. New Zealand Journal of Agriculture, Aug. 1959, 99, (2), 103.)

Forestry: It is reported that the white-fringed bettle, *Graphognathus leucoloma*, again proved troublesome in Woodhill Nursery but was controlled with dieldrin. Grass grubs did considerable damage in Inglewood and Rangiora Nurseries; in the latter area, converted from pasture during the year, a light dosage of D.D.T. was ineffective.

(Report of the Director of Forestry for the year ended 31 March, 1959.)

SOUTH AFRICA

Bilharziasis Control: "It has been found that in certain types of naturally occurring waters most copper sulphate, (a common molluscicide), immediately precipitates out and is rendered useless for killing snails. To add more copper sulphate than the water can hold is a waste and, moreover, if the insoluble precipitated copper continues to accumulate in the soil it will become a matter of concern to the farming community.

The investigation of the epidemiology of a disease is one that is most likely to yield important data on prevention and control. Except in certain areas in the Far East, it is usually accepted that man is the only host of human bilharziasis, and that if the disease can be stamped out in man the chain will be broken. Nevertheless near and around Komatipoort it has been found that as many as 25% of people are infected with the bilharzial worm of cattle. This very important discovery means that animal reservoir hosts for human disease will have to be taken into serious consideration.

The assessment of bilharzia control projects is difficult, but experience with the molluscicide copper sulphate over a period of no less than five years have now been collated, and have divulged that under most conditions copper sulphate is of little value. The conditions under which it will give results have, however, also been revealed. This work has taken a long time to complete but it is at last known that present methods waste time and money and that other techniques and molluscicides must be tried. Chemists of the Unit have been watching the behaviour of other molluscicides of repute. An attempt, for instance, was made to keep a constant concentration of the well-known molluscicide, sodium pentachlorophenate in flowing canal water by constant drip. Had such a technique proved satisfactory it would have been a great help in control as the molluscicide would have been applied at only one spot, thus dispensing with much labour and transport. But the chemists found that sodium pentachlorophenate in solution disappeared within a very short distance from its point of application. Investigations disclosed that in the Lowveld waters sunlight alone was enough to decompose the molluscicide and to account for its disappearance. A molluscicide that behaved in this fashion would be of little use in South Africa."

(South African Council for Scientific and Industrial Research. Thirteenth Annual Report 1957-1958.)

Leather: Further work has been carried out on the use of dieldrin against the hides and skins beetle, using goatskins and Karakul skins as experimental material. The effectiveness of dieldrin has again been proved, and it has also been found that contact between treated and untreated skins transfers sufficient of this insecticide to protect the untreated stock. Experiments with a combined antiseptic and insecticide used in the wash water prior to stretching the skins to dry have given very promising results.

(Leather Industries Research Institute, Annual Report 1st Apr. 1958-31st March 1959.)

NEWS ITEMS FROM THE COLONIAL TERRITORIES

BRITISH GUIANA

Citrus: The black bee, Melipona guianae, was controlled effectively by DDT and malathion.

Coconut: The moth borer, Castnia daedalus, was controlled to some extent by spraying affected palms with 1% dieldrin. Recommended measures against coconut caterpillar, Brassolis sophorae, were hand cleaning and spraying with 0.5% dieldrin.

Cotton: 1% dieldrin is said to be effective for controlling Alabama argillacea.

Rice: BHC dusting was carried out against outbreaks of the padi bug, Mormidea poecila. Drift-dusting experiments showed Agrocide 7 effective at the rate of 15 lb./ac. with Pyrex as carrier (a limestone carrier was unsuitable for use with the "Motoblo"). Seed treatment trials with aldrin, dieldrin and Dieldrex C are being carried out against rice water weevil, Lissorhoptrus sp.

Sugar Cane: Against outbreaks of the yellow aphid, Sipha flava, malathion sprays gave effective control in some instances.

(Annual Report of the Director of Agriculture for the Year 1958.)

BRITISH HONDURAS

Malaria: It is reported that eradication work continued, 17,369 houses out of a total of 17,669 houses in the country being residually sprayed with dieldrin.

(Report for the year 1957.)

CYPRUS

Locust Control: Moroccan locusts, Dociostaurus maroccanus, appeared in Nicosia, Kyrenia, Famagusta and Larnaca districts. The population density was small, similar to that of the previous year, but a full scale campaign was considered necessary to prevent eventual increase of population. The same control methods were used as in previous years, that is, dusting with BHC (Agrocide 7) at the early hopper stages and baiting with a BHC (Agrocide 15W) bran bait at the later stages. As a result of the control measures taken no damage to cereals or other spring crops was reported.

Stink Bug, *Dolycoris baccarum*, was again found in abundance during the summer on the Chionestra peak of the Troodos mountain range. Control measures were taken by dusting with BHC (Agrocide 7) and satisfactory results were obtained.

Rat Control: Zinc phosphide or arsenious oxide in a bait of crushed barley soaked with water were used against *Rattus rattus frugivorus*, a serious pest of the carob tree. Zinc phosphide appeared to be the more effective poison.

(Annual Report of the Department of Agriculture for the Year 1958.)

DOMINICA

Cocoa: The incidence of *Phytophthora* in potted cuttings in storage has shown considerable reduction recently. This is thought to be a direct result of using plastic netting and galvanised strips for shade in place of wood and bamboo slats. No serious pests or diseases occurred.

(Annual Report of the Department of Agriculture and Forestry, 1956 and 1957.)

EAST AFRICA

Work with Radioactive Isotopes: By hatching mosquito eggs and rearing the larvae in solutions containing Na22, it has been possible to obtain mosquitoes showing a high degree of γ radio-activity. It is hoped, by feeding these creatures on subjects with microfilariae in the blood, to obtain infective larvae of *Wuchereria bancrofti* which are themselves radio-active: if these are in turn introduced into the body through the bite of the mosquitoes harbouring them, it is hoped to follow their migrations through the tissues with a directional scintillator head.

Entomological Parasitology: Experiments to determine the incidence of infective larvae in mosquitoes feeding on persons with different densities of microfilariae have continued using *C. fatigans* and *Anopheles gambiae*. Although many persons with low density counts have now been used in these experiments, persons with high density counts have not been available. This is particularly unfortunate, as more information is required about the immediate effect on these mosquitoes of large concentrations of microfilariae in a blood meal, and later, the effect of many infective larvae in the thorax, head and mouth parts. The *A.gambiae* experiments have been restricted owing to difficulties with the colony. The effect of a blood meal on infective larvae of *W.bancrofti* in the head, thorax, and abdomen of *C.fatigans* was studied. It appears that the majority of larvae in these parts are attracted to, and pass out of the proboscis when a mosquito feeds.

Bilharziasis - Snail Vector Research: Great difficulty has been experienced in breeding certain species for experimental work. However, two local forms of *Biomphalaria* which may be different species have been bred and infected with *S.mansoni* without difficulty. *Bulinus africanus* has been successfully infected with *S.haematobium*. This snail does not seem to be a very suitable host, as the parasite does not always develop, and there is a high mortality among snails. Cercariae developed in snails kept in an aquarium heated to 28°C in 34 days, whereas they required 43 days for development in a tank at room temperature of 25°C. Attempts to infect *B.tropicus zanzibaricus* have consistently failed. Some preliminary tests were carried out with sodium pentachlorophenate as a molluscicide.

Relapsing Fever Research: Considerable progress was made, in the quantity production of preserved and living material of pure and supporting cultures of six biological variants of *Ornithodorus moubata*, in confirming their charactistics up to the third generation, and in testing their reactions to desiccation as a further means of differentiation preparatory to making an intensive study of the taxonomy of the whole group.

(East Africa High Commission. East African Institute for Medical Research, Report 1957-58.)

FIJI

Agricultural Pests and Diseases. I.

Banana: In order to minimize the amount of damage done to the bananas when dusting with 2% DDT to prevent scabbing by scab moth a series of observations using 20% DDT emulsion sprayed on the surrounding leaves and Soba before the bunch emerges are being carried out. Dieldrin is being used to spray and dip all planting materials used in trials to reduce damage by banana borer. Three gallons of 15% dieldrin, diluted 1:150 is used on 10 plants and the grounds and base of standing plants are sprayed with dieldrin every 6 months. Oil spraying with Micronette sprayer using Shell Silver oil S.A.E. 20 was started and has proved satisfactory. The high volume spraying with zineb has been discontinued. To avoid clogging of the jets with zineb/oil, diesoline is also added to the mixture.

Cocoa: The rose beetle, *Adoretus versutus*, continued to cause damage, especially to unshaded cocoa, but was effectively controlled by three sprays of 15% dieldrin E.C. Outbreaks of *Prodenia litura* were eradicated by dusting with 2% DDT dust.

Coconut: Climbing of palms in infested areas and treatment of the crowns with a mixture of BHC 50% dispersible powder and sawdust has continued throughout the year.

Residual Insecticides - Assessment of Deposits

An experiment has been conducted to find the rate of loss of DDT and dieldrin from boards made of the same materials as the Fijian houses; also to find the relative values of acetone and water for recovery of the insecticide for sampling purposes. "Eight boards each measuring 4 feet square were made of reeds about half an inch in diameter in the same manner that they are made for Fijian houses. Another 8 boards were made from split bamboo, the slats being about one inch wide.

Two per cent solutions of DDT and dieldrin in water suspension were then prepared and carefully sprayed on the boards, so as to obtain an even coverage of the calculated quantity. A "Rega" continuous sprayer was used for applying the insecticide. A quantity of solution was put in the sprayer which was then weighed and a check kept on the weight until sufficient solution had been applied to give the required concentration on the boards. Immediately after drying (about ½ an hour) the boards were sampled for analysis and were then kept in upright positions in a closed room. The boards were kept end to end leaving about one foot between each one. It should be noted that there was no free air movement in these experiments. The treatments were as follows:-

(a) Two reed boards received 300 mg/sq.ft. of DDT
(b) " " " " 600 " " " "
(c) " " " " 94 " " " dieldrin
(d) " " " " 188 " " " "
(e) Two Split bamboo " 300 " " " DDT
(f) " " " " 600 " " " "
(g) Three Split bamboo " 188 " " " dieldrin
(h) One " " " 94 " " " "

Periodic samples were taken from each board using:

(a) Cotton wool moistened with acetone.
(b) Cotton wool moistened with distilled water, for analytical work.

Three random samples from areas each measuring 6" x 2" were taken from individual boards using moistened cotton wool, as indicated above. Each set of three samples was placed in one container and analysed. Filter papers were also placed behind each board before spraying and were later analysed to find what loss might be expected by the spray passing directly through the lattice work.

Approximately 50-60% of the insecticides applied were recovered by the first samples taken. A proportion of the amount sprayed must have been lost as the result of particles bouncing off the board. As the spraying was done in a closed room in the absence of air draughts it is unlikely that very much would have been lost in the air as drift, and the percentage passing through the interspaces of the materials was usually small. It might therefore be concluded that the sampling technique used only recovers a proportion of the insecticide actually applied, the remainder is either inaccessible to the swab used or the accessible insecticide is only partially recovered.

In the case of DDT a much better recovery is obtained with water as opposed to acetone. The better recovery from the reed is probably due to the fact that leaf sheaths which extend from the nodes are able to be totally removed during sampling and retained for analyses. A slightly better recovery is obtained by the use of acetone rather than water, for the recovery of dieldrin. With DDT there is steady fall off in concentration for about the first month after which it remains fairly constant for the next 6 months at least. In dieldrin the loss is more rapid and continues for about 7 or 8 months indicating that at about 8% concentration of dieldrin further loss is only slight.

Conclusions

1. This experiment confirms that swabs of cotton wool soaked in water are about as good as or better than cotton wool soaked in acetone, for the purposes of recovering dieldrin or DDT.

2. Six months or so after applying insecticide further loss is only slight and it might be suggested that samples taken for analyses from treated dwellings need only be taken at well spaced intervals.

3. Allowance will have to be made at all times for the fact that the sampling technique used only recovers a percentage of the insecticide which was sprayed on to the boards".

(Department of Agriculture, Bull. No. 34. Annual Reports of Divisional and Specialist Officers 1957.)

Agricultural Pests and Diseases. II.

Copra: The campaign against the Coconut Rhinoceros Beetle, *Oryctes rhinoceros* L., at a cost of approximately £62,000, continues. The pest is gradually spreading and increasing in number on the island of Viti Levu, but has not yet been recorded elsewhere. The parasite *Scolia ruficornis* has been introduced from the U.S. Trust Territories of the

Pacific and is being bred in the most severely affected area. Regular field releases of the nematodes, Rhabelitis spp., which prey on Oryctes, have been made throughout the year. It is not known whether they have become established. It is not yet known whether parasites of the small coconut moth, Agonoxena argaula Meyr. sent from New Guinea, have become established in Fiji.

Bananas: The normal pest control practices included spraying with oils to control leaf spot (Sigatoka Disease), spraying and dusting with D.D.T. to control scab moth and spraying with dieldrin to control borer.

Mr. R. W. Paine completed his investigation of parasites of the banana scab moth Nacoleia octasema Meyr., in New Guinea in April of this year. Though a number of species of parasites was found and the most promising species was bred and released in large numbers in Fiji, there is no evidence that it has become established. There appear to be two biological races of the moth, one of which feeds on banana, and the other on Pandanus and Heliconia. Aided by a grant from the Colonial Development and Welfare Fund, the Fiji Government has engaged Mr. Paine for a further period of two years. During this time he will investigate the pest in Malaya, Borneo, the Celebes and the Moluccas and possibly other areas. Special attention will be devoted to the problem of biological races and their parasites. This project will begin in April, 1959.

Sweet Potatoes: Treatment of the growing crop with dieldrin sprays is said to control weevil attack.

Miscellaneous: The tachinid parasite of armyworms, Achaetoreura archippivora, of which more than 9,000 adults were liberated in the field, has not yet been recovered. It is hoped that further investigation will reveal its presence.

A colony of the moth Syngamia haemorrhoidalis Guen., which breeds on the leaves of Lantana, was introduced from Hawaii in February, and bred in the laboratory. Over 600 of the moths have been liberated in Lantana stands during the year, but again it is not yet known whether it has become established.

(Annual Report for the year 1958, Department of Agriculture, Legislative Council of Fiji, Council paper No. 9 of 1959.)

HONG KONG

Malaria control: The method of control continues to be mainly based on anti-larval measures.

Since 1957 anti-malaria oil has been employed as the main larvicide. In view of insecticide resistance problems, the use of Gammexane Dispersible Powder (P520) has now been confined to agricultural lands where the application of oil would be unsuitable.

(Annual Report, 1958)

Crop Pests and Plant Disease Control: The insect pest and plant disease control team visited 97 villages, spraying and assisting in spraying 580.7 dou chung[x] of crops and 4,936 fruit trees. During these operations 55 sprayers and 70 gallons of insecticide were used.

Forest Pests. There was a local outbreak of pine caterpillars in the Ngau Chi Wan area of Kowloon. This pest had not appeared in forest reserves for a number of years.

(Director of Agriculture, Fisheries and Forestry. Annual Departmental Reports 1957-58).

KENYA

Barley

Experiments with dry seed dressings to control barley fly showed that dieldrin and heptachlor were better than aldrin or endrin. Thiodan and thiometon were ineffective. A dieldrin spray applied three days after emergence of the coleoptile gave better control than seed dressings (10 oz. of 50% to 100 lb. of seed) was found superior to lower levels of dosage. Nandi Setaria at Nakuru was found to be an alternative host of the fly.

Beans

In an experiment against bean fly almost complete protection was given to beans in early growth by the use of seed dressings. Aldrin was better than dieldrin or gamma BHC.

Coffee

Entomology: The two main lines of investigation were the biology and control of the tip stem borer, Eucosma nereidopa Meyr., and improved methods of chemical control of the leaf miners, Leucoptera meyricki Ghes. and Leucoptera caffeina Wshbn.

[x] Note: 6 dou chung = 1 acre.

Detailed studies of the distribution of the night-flying *Eucosma* moth in the plantation, when at rest during daylight hours were made. Most occurred on the trunks of the coffee and shade trees. Many persistent insecticides were screened to find one suitable for spraying on the tree trunks. Five showed promise. Systemic insecticides against the caterpillars in the sucker tips were disappointing when used at economic rates. Much general information on the life history of this pest was acquired.

Three of the newer insecticides were found to kill *Leucoptera* caterpillars in closed mines, but further field trials are required before they can be recommended as alternatives to diazinon or parathion. Pyrethrum, sprayed as an emulsion, gave a good kill of *Leucoptera* eggs at what may prove to be economic concentrations. Further laboratory work in co-operation with the Pyrethrum Board of Kenya is in progress. Heavy overhead irrigation killed (by drowning) almost all the caterpillars feeding in open mines - about 25% of the total larval population. Work on the parasite complex continues.

Opportunities were taken to test some of the newer insecticides against the scale insects, *Ceroplastes luteolus* De Lotto, *Saissetia coffeae*, and *Asterolecanium coffeae* Newst. Both malathion and parathion gave good control of the lace bug, *Habrochila ghesquierei* Schout. and one or the other is now in general use against this pest. New pyrethrum formulations gave disappointing results in trials against the antestia bug (*Antestiopsis* spp.) but aerial spraying with malathion was successful.

Berry Disease: In the East Rift it has been conclusively shown that the critical period for control is the 11 weeks centred on the flowering period. This period needs detailed study and field experiments on this have been designed and completed. Results are now coming in. In the West Rift, the necessity for two control periods has been confirmed. Extensive trials for the further study of these are complete, but results are not yet available.

During the year, the use of mercurial sprays has been abandoned, partly because of their poisonous nature and partly because of their phytotoxic effect. Captan formulations, which this year's comparative trials have shown to be effective, are now used.

A severe outbreak of leaf rust on one field trial has enabled observations on the effects of captan to be made. These are most encouraging; it is clear that the fungicide has affected not merely the rust fungus but the syndrome.

Laboratory work has concentrated on the relationship between disease incidence and inoculum potential. It has been shown that the infection potential of a plantation is in the main the result of inoculum production on the maturing twigs and not from the fruit, and that control treatments, in all probability are efficacious in that they affect this source of infection. This discovery is in complete accord with all field evidence and epidemiological studies and will, it is hoped, form the theoretical basis on which spray schedules will, in future, be determined. Studies on the relationship between infection-potential, infection, and growth characteristics, as affected by fungicidal sprays, are in hand.

Cotton

In the lake shore area figures so far received show yields increased from 290 lb. per acre seed cotton (50% stained) to 700 lb. per acre (20% stained) due to dusting with 60 or 80 lb. per acre of BHC/DDT cotton dust.

Maize

A trial at Kitale showed that endrin and dieldrin granules and aldrin and dieldrin dusts gave effective control of maize stalk borer.

Pyrethrum

Red spider mite was controlled by Rogor, Kelthane and Tedion while control of thrips was given by DDT, chlorthion, Metasystox and Rogor. A new sampling technique, involving the use of a benzene-water interface, has given good results and increased the efficiency and speed of examining samples.

Stored Products

Fumigation and long-term storage under polyethylene sheeting was the most promising development of the year. At the Coast a stored products entomologist found that a rapid reinfestation of *Tribolium castaneum* occurred following fumigation of maize. Work on dusting large stacks of maize with 0.5% gamma BHC resulted in a more refined technique. Several trials were directed at the control of moths in large maize stores. A fumigation of a store rendered gastight by sealing all openings was most promising. A search of the port and the other parts of Mombasa was undertaken to find *Trogoderma granarium*. No established centre of infestation was found.

Quelea

Breeding Colony Control: In close co-operation with Tanganyika large-scale *Quelea* breeding colony control was carried out for the first six months of the year. A total of some 2,610 acres of dense breeding colonies were dealt with, using flame-throwers, destroying an estimated 60,500,000 young birds. 760 acres of these colonies were located in Kenya, the balance being found from some 80 miles south of Dodoma to the Northern Province of Tanganyika in the Tanganyika Rift.

Roost Control in Agricultural Areas: Severe invasions commenced entering the Lower Rift Valley wheatlands in early July, and a full-scale control was necessary until mid-December to save large-scale losses in most areas. During the first two months of the invasion, some very large concentrations were quickly located and dealt with, and thereafter smaller roosts, often in very difficult sites in reeds over deep water, had to be contended with. In all, eight aerial night spraying operations using a formulation of parathion and 26 blow-ups of various sizes took place, destroying an estimated 6,552,000 birds.

(Department of Agriculture, Annual Report 1958, Vol. I.)

MAURITIUS

Beans: It is reported that the large scale cultivation of this crop has been largely due to the control of Melanoagromyza phaseoli by the application of dieldrin at the two-leaf stage. In trials against leaf spot, a zineb formulation gave practically complete control compared with a copper preparation.

Sugar-cane: A histo-chemical test using 2,3,5-triphenyl tetrazolium chloride for diagnosing ratoon stunting disease was developed. Experimental evidence shows that aerial transmission of chlorotic streak does not take place and that the disease is acquired through the soil.

(Department of Agriculture, Annual Report 1957.)

NIGERIA

Cereals: An experiment on the late maize crop at Moor Plantation (Ibadan) in 1957 showed that endrin, applied as a spray at 6 oz. active ingredient per acre, 8 and 14 days after planting, gave a good increase in yield which was probably due to stem borer control. The most obvious effect of the insecticides used was on the loss of stand between thinning and harvest and on the number of stems per plot bearing cobs. The results are summarised in the table.

Treatment	Yield lb. grain/ acre	Per cent loss of stand between thinning and harvest	Per cent stems severely bored at harvest	No. of stems per plot bearing good cobs
Endrin spray 6 oz. a.i./ac.	1,007	6	19	339
Dieldrin dust 6 oz. a.i./ac.	919	10	35	285
Heptachlor spray 6 oz. a.i./ac.	842	12	32	263
Malathion spray 10 oz./ac.	814	17	31	249
Control	747	22	31	250
DDT dust 16 oz./ac.	736	21	34	219
5% significant difference	± 179	± 5.2	± 7.7	± 51
1% significant difference	± 240	± 7.1	± 10.5	± 69
0.1% significant difference		± 9.5	± 14.0	± 92

Yams: In trials against yam beetles, Heteroligus spp., yam setts treated with 0.45% gamma BHC dust gave increases in yield over those in untreated plots averaging 7% (range - 20% to + 38%). In experiments where the attack rate on untreated plots was over 20%, the average yield increase caused by this insecticide was 11%. A new formulation containing 0.5% gamma BHC, which is to be marketed in Nigeria, gave an average increase of 16% in yield. Other insecticides used were 2.5% aldrin, 2.0% dieldrin, 1.0% endrin and 5% chlordane and they were applied as dusts to the yam setts before planting. In all experiments, they gave yield increases of 14, 8, 7 and 8% respectively over untreated plots. In experiments where over 20% of yams in untreated plots were attacked, they increased yields by 26, 18, 16 and 20% respectively. These dusts which have given promising indications are more expensive than the 0.45% gamma BHC. Further investigations are required to determine whether their increased effectiveness may justify their use on economic grounds.

Plots treated with 0.45% gamma BHC showed less damage than untreated plots by an average of 43%. The 0.5% gamma BHC reduced damage by 40%. These results are to be expected from dusts so similar in content. The new insecticides, aldrin, dieldrin, endrin and chlordane reduced damage by 36, 49, 68 and 58% respectively.

Thus the insecticides tried this year for the first time showed distinctly better results than the lower concentrations of BHC dusts, both in yield increase and control of yam beetle. Of the four, 2.5% aldrin and 5% chlordane appear to be the most promising. Endrin is effective but is too poisonous to man to be recommended for general use. Dieldrin has not shown such good results as aldrin except in one trial where the yams were planted in January in Rivers Province, and here it was much more effective than aldrin. It is possible that dieldrin, with its greater persistency, may be of use in areas where yams are normally planted very early.

In palatability tests 80 yams were sampled from plots treated with 2.5% aldrin, 2.0% dieldrin and 1.0% endrin, and 240 from untreated plots. Of these, 4, 7, 5 and 9 yams respectively were said to have a bad flavour. The insecticide treated yams did have a slightly higher proportion of bad flavoured yams but the differences were not statistically significant, and it seems unlikely that the insecticides were responsible for any deleterious effect upon the flavour of the yams.

(Annual Report of the Department of Agricultural Research for the Year 1957-58.)

Cocoa

Routine Pest Control Measures: Following the abandonment of spraying with synergised pyrethrins in January 1957, a revised control programme was put forward by West African Stored Products Research Unit in July 1957. This programme was based essentially on fumigation with methyl bromide and subsequent storage away from sources of infestation.

At Apapa Wharf cocoa is stored in the very large "A" Warehouse prior to shipment, and in view of the proximity of the groundnut transit sheds, special precautionary measures are still being taken to reduce flying storage pests. Routine misting at dusk is carried out inside "A" Warehouse using synergised pyrethrins and a new programme of daily spraying has been started inside the four groundnut transit sheds.

In addition to the foregoing routine measures which are applied to produce, routine arrangements have been put into operation to treat the fabric of all cocoa warehouses with a persistent insecticide. DDT had been applied as a water miscible oil using a motorised knapsack sprayer to give a deposit of approximately 200 mg per square foot on walls and ceilings. All official cocoa warehouses in the Western Region were treated in this manner in August-September 1957 and the majority of the important ones in August-September 1958 when they were empty prior to the opening of the main crop season.

Taint Trial: Application of insecticides to bagged stored cocoa to control storage pests is limited by the requirements of the Cocoa, Chocolate and Confectionery Alliance of the United Kingdom who only approve pyrethrin-based insecticides for this purpose. As already indicated, insecticides based on pyrethrins are likely to have little future application for this specific problem in West Africa. In consequence it was decided to carry out a study of the objections to insecticides of other types to ascertain whether or not these objections were truly justified.

Trials were set up in both Ghana and Nigeria in which cocoa beans were treated with various formulations containing lindane and DDT. It is concluded that in cocoa beans admixed with lindane dust to concentrations of 20 p.p.m. and stored for periods of about four and seven months before shipment to the U.K., the quantity of gamma-BHC present in the whole bean was very low. When roasted and made into chocolate, no off-flavour was detected. Cocoa beans stored for at least six months in sacks which have been dusted or sprayed on the surface with lindane to give 40 mg per sq. ft. of gamma-BHC or in sacks sprayed on the surface with DDT paste to give 100 and 400 mg per sq. ft. of DDT had a low insecticidal content, and when roasted and made into chocolate no off-flavour was detected.

Although from the point of view of chemical contamination and organoleptic consideration there would appear to be no valid objections to the use of these insecticides in the manner employed in the trial, the results obtained with regard to insect control were not so efficacious as had been anticipated.

Insecticidal Misting of Bagged Cocoa Beans: 0.3% pyrethrum with 3.0% piperonyl butoxide in a mineral oil was applied to bag surfaces at a rate of 1 gal. to 2,000 sq. ft. three times a week and the treatment was carried out from early in the storage season (15th November, 1957) to late February 1958, by which time most of the cocoa remaining was about to be evacuated to port. The present work was particularly in respect of *Ephestia cautella*, whereas the earlier work was mainly concerned with the beetles *Tribolium castaneum* and *Lasioderma serricorne*.

The misting was designed to give immediate knockdown in space while at the same time laying down a toxic deposit on the bags. The work was carried out in three towns, Ibadan, Ijebu-Ode, and Abeokuta. In each place about half the cocoa stores were misted while half remained untreated. Stores to be misted were chosen in various parts of the town so as to be representative of the various types of cocoa stores in use. Similar stores were chosen as controls in such a way that they could be paired, one misted with one control. In the final examination, bags which had been stored for the same length of time were chosen from each pair of stores.

It appears from the data obtained that heavy infestations could be present in cocoa stores which were being regularly misted by the method used in these experiments, and confirms the view that misting in this manner is unlikely to have much practical application for this type of work. It was probable that the treatment was having some effect on E.cautella larvae since the numbers found inside bags were somewhat less in the misted stores than in the unmisted stores. However, large numbers of E.cautella adults were seen on Ate strands in the misted store. It was unfortunate that the only other insect which was apparently reduced by misting was the parasite Bracon hebetor Say, which at times may be a serious enemy of E.cautella.

It is felt that misting might have been more successful if carried out at dusk when the insects were more active, but the practical problems of misting large numbers of stores within the hour about dusk would be considerable and under present conditions could not be carried out efficiently on a large scale.

Treating Cocoa Beans by Admixture of Synergised Pyrethrins Powder: Tests have been carried out on a proprietary brand of pyrethrins/piperonyl butoxide dusting powder, to assess the suitability of the powder for the protection of stored cocoa beans against infestation by insects. Small scale storage trials were set up in a cocoa warehouse and in the laboratory, at Ibadan, using two types of powder. Type A contained 0.15% pyrethrins with 2.4% piperonyl butoxide in a blend of inorganic/organic carrier while Type B contained 0.3% pyrethrins with 4.8% piperonyl butoxide in the same carrier as Type A.

In the warehouse trial seven standard 140-lb. bags of recently graded Grade I cocoa were turned down and "snaked" for insect counts, yielding an average of 6.5 insects per bag, most of which were Ahasverus advena Waltl. Sampling at the same time gave estimates of 1 insect per 1,000 beans 0.27% of beans damaged by insects and 0.9% mouldy. The cocoa was rebagged into thirty 30-lb. bags while mixing in the appropriate concentrations of dust. The five dosage rates were each replicated in five bags together with a control. The bags were sticked in a normal trading store and examined three and a half months later by methods similar to those used initially.

Protection Offered to Bagged Cocoa Beans by Admixture
with a Pyrethrum Based Powder

Treatment			Mean Numbers of Certain Species of Insects Seen Per Bag when Snaking After 3½ Months' Storage				Insect Damaged Beans Found by Sampling %
No.	Type of Powder Admixed	Proportion of Powder to Cocoa Beans w/w	*T. castaneum*	*E. cautella*	*O. mercator*	Total insects	
4	B	1/300	3.4	0.6	9.4	13.6	0.6
1	A	1/300	3.6	0.4	37.0	41.0	0.7
5	B	1/600	6.6	2.0	28.2	37.4	0.9
2	A	1/600	5.8	0.8	105.8	112.4	0.8
3	A	1/1200	7.0	1.0	131.0	139.2	0.6
No treatment			9.2	1.2	97.0	115.2	1.4

The results suggested that treatments 1, 4 and 5 (the three heaviest dosages) reduced the build-up of *Oryzaephilus mercator* compared with the other treatments. In both treated and control bags the proportion of beans damaged by insects was more than double that found initially, so that none of the dosages employed could be considered completely effective, though it is possible that the powder was more effective in the earlier part of the period of storage. In the laboratory trial, samples of cocoa taken from the warehouse experiment were placed in insect breeding cages and dusted with the synergised pyrethrin powder at the same rates as described in treatments 1, 2 and 3 above. Adult *E. cautella*, *L. serricorne* and *T. castaneum* were added immediately after dusting. Two replicates of each treatment and control were set up.

After four months the cocoa in the cages was examined. Counts of insects alive and dead showed that *E. cautella* had developed in all treatments but that it was far more numerous in the cocoa treated with synergised pyrethrins than in the control. Treatments 1, 2, 3 and control showed respectively 86, 52, 67 and 2 adult *E. cautella* alive and 421, 458, 305 and 113 dead. The heaviest dosage appeared to have controlled *L. serricorne* and *T. castaneum* and it may be that the low numbers of E. cautella in the control are related to the large numbers of *T. castaneum* and *L. serricorne*.

The results suggest that powder containing synergised pyrethrins is effective against beetles on cocoa but can cause increased numbers of *E. cautella* by eliminating its enemies while being non-toxic to the moth.

Tests on Various Types of Sacks Used for Storage of Cocoa Beans: Cocoa beans in Nigeria are normally stored and shipped in B-twill hessian bags. Tests were carried out on several other types of bags mainly to determine their suitability for preventing reinfestation of cocoa beans by insects after in situ fumigation with methyl bromide. Paper-lined hessian bags appeared to be the most promising type. There was an indication that the paper-lined bags caused a greater increase of mouldy beans than the simple hessian bags, but an analysis of the results did not substantiate this, and previous work in Nigeria on multi-wall paper bags did not suggest that there was any difference between paper containers and hessian as far as mould development was concerned. The bags of a heavier weave than that of the normal B-twill allowed some insect penetration but not as much as the B-twill and the fine-mangled hessian. The heavy weave bags cost about 2s. 6d. per bag more than the B-twill, however, and it was not considered that the advantages would offset this extra cost.

It was concluded that there is not sufficient evidence at present to warrant changing the standard pack of cocoa from B-twill to any of the other types of bags examined.

Groundnuts

Routine Application of Malathion: In 1957 a new routine spraying programme was started in the Kano area in which malathion was substituted for BHC as the former insecticide was found to be far more effective against T. castaneum. The technique consists of spraying the external surfaces of all stacks of bagged groundnuts with aqueous suspensions of malathion. In addition to the foregoing spraying treatment the edges of groundnut pyramid plinths and the edges of the Sisalkraft paper protruding under the stack where T. castaneum habitually congregate, have been subjected to routine treatment, using 4% malathion dust applied with a motorised knapsack blower.

In the past regular attempts have been made by the Pest Control Unit to destroy large numbers of T. castaneum by taking advantage of their usual dusk flight at times of the year when their numbers are greatest. For this purpose an insecticidal fog containing synergised pyrethrins has been applied up-wind of storage sites using a T.I.F.A. machine. Arrangements are being made for carrying out more intensive operations using portable pulse jet applicators giving a fog containing malathion. In the first instance the use of these machines will constitute a large-scale experiment and will commence in March 1959 when numbers of T. castaneum will be increasing. Similar fogging operations have been planned for applying each evening at dusk to groundnuts in transit at Apapa.

Comparison of diazinon with malathion: Laboratory trials showed that malathion was highly effective in killing T. granarium larvae which were unaffected by BHC and most other insecticides. Infestations by T. granarium in Kano are largely confined to premises which are not conveniently fumigated *in toto* and it was hoped that spraying with malathion would prove effective for this purpose. Unfortunately, malathion is unstable under alkaline conditions, and as most of the stores requiring treatment are constructed with cement and plaster, malathion was found to have no better effect than BHC.

A proprietary preparation based on diazinon, which was said to be a potent insecticide but of lower mammalian toxicity than BHC, was examined. The material was also claimed to be stable under weakly alkaline conditions, and it was therefore decided to carry out some trials to compare the insecticidal properties of this preparation with malathion with respect to T. granarium and T. castaneum.

Results showed that diazinon has the quicker insecticidal effect although after three weeks the differences between the two insecticides were very small. Malathion at 150 mg/sq. ft. showed 50% kill after seventeen days whereas diazinon at 150 mg/sq. ft. and 100 mg/sq. ft. showed 50% kill after fifteen and sixteen days respectively.

Tests of a similar type with T. castaneum adults have shown that diazinon at a deposit of 22 mg/sq. ft. is as good as malathion at 52 mg/sq. ft. over a period of forty-two days. This trial is continuing. In addition diazinon has been shown to have an appreciable fumigant action. Although the most attractive feature of diazinon, viz. its stability on concrete walls, has not yet been investigated, it is hoped to carry out a trial in the near future.

(Department of Marketing and Exports, Nigeria. West African Stored Products Research Unit, Annual Report, 1958.)

NYASALAND

Maize Stalk Borer (Busseola fusca and Chilo zonellus): An experiment designed to test the effectiveness of one and two applications of 5% DDT dust against maize stalk borer was carried out at 4 different sites in the Highland areas of the country. The experiment was of split plot design and the main treatments consisted of 4 different planting dates, i.e. dry planting, planting with first rains, planting 14 days from first rains and planting 28 days from first rains. These main plots were then split for insecticide treatment, i.e. no insecticide, one application of 10 lb. 5% DDT per acre and 2 applications of 7½ lb. 5% DDT per acre. Insecticide treatments were carried out when the maize was 18" high at "funnel" stage. Where two applications were made the second one was made 14 days after the first. In terms of yield of shelled maize per acre both insecticide treatments resulted in an increase of just over 20% in the early planted plots and 15% over the whole experiment.

Tobacco Root Knot Eelworm: A simple experiment was carried out to test the effectiveness of sodium n-methyl dithiocarbamate against tobacco root knot eelworm, *Meloidogyne javanica*, under Nyasaland conditions. It is especially suitable for use by Africans growing tobacco, by virtue of the ease with which it can be applied, i.e. with a watering can. The seed bed site chosen was known to be well infested with eelworm. The experiment had 2 treatments, Unifume and no Unifume; there were 3 blocks. The treatment was carried out exactly according to the maker's instructions at a rate of 2 pints Unifume to 100 square feet of seed bed and the maximum recommended period (25 days) allowed to elapse before seed beds were sown. One month after sowing, 6 soil core samples (5 cm. in diameter and 8 cm. in depth) were taken from each plot and the soil carefully washed from the tobacco seedling roots. The roots were then sub-sampled and 50 1-inch lengths taken from the root mass; these lengths were examined under the binocular microscope for lesions caused by eelworm attack. Results showed that almost complete control had been obtained of eelworm at this stage.

Tobacco Budworm, *Plusia acuta*: In fields where the attack was serious the pest was controlled by treatment with 10% DDT at a rate of 10 lb. per acre, applied as a "pinch" to the growing point of each plant.

Dysdercus:

(1) Chemical Control on Alternate Hosts: Preliminary experiments were carried out this season to test the effect of persistent soil-insecticides sprayed on the trunk and on the soil under the canopy of *Sterculia africana*. Great difficulty was experienced in finding seriously infested hosts. In the end, trees supporting very low stainer populations had to be used. Due to this and because the effect cannot be measured in one season, results were inconclusive although dieldrin showed more promise than chlordane. Next season experiments will be continued on a larger scale if conditions allow.

(2) Chemical Control on the Cotton Crop: Although *Dysdercus* may be killed by a range of insecticides using six to ten or more applications in the season, this is uneconomic and impracticable under conditions of agriculture and climate in the Lower River. Experiments were therefore initiated using persistent insecticides (chiefly chlordane, dieldrin and aldrin) at relatively heavy dosages, the hypothesis being that, with such insecticides, only one or two applications might be

necessary in a season. The effect of rain wash was not great but needs to be studied further. As in other experiments, the effect of treatments was masked due to the very low populations of Dysdercus this season, and in only one experiment was there a significant difference at the 5% level between total yields. The relatively heavy rate of 5 lb. active ingredient per acre was used. It is considered that the increase in yield in the treated plots was largely due to the control of insects other than Dysdercus and the differences in the amount of Grade II cotton were disappointing.

(3) Biotic Control: Experiments were carried out using a predaceous reduviid, Phonoctonus nigrofasciatus. This insect is only likely to be of use in conjunction with other methods of control and not as a control per se. It holds most promise for use in connection with the partial eradication of S.africana, but releases were also made this season on selected cotton fields as well as on alternate host trees.

In cotton fields it was found that there was too great a tendency for the predators to wander and that vast numbers would be needed to effect an adequate control. Although control of Dysdercus in cotton fields by this means has never been seriously considered at any time, some interesting data were obtained following their release.

More promising results were obtained in an experiment on the release of predators to control Dysdercus on S.africana. In this experiment three releases each consisting of 10 fifth instar P.nigrofasciatus were made on each of 10 trees, but due to the low numbers of Dysdercus another closely related pyrrhocorid Odontopus exsanguis, had to be used as an indicator insect. The predator feeds only on pyrrhocorids and survives in the dry season chiefly on Odontopus.

On all these trees a very considerable decrease in host insects occurred, while host insects on control trees increased. The results indicate the need for further experiments next season.

(Annual Report of the Department of Agriculture for the Year 1957/8, (Part II).)

RHODESIA

Maize Ladybird, Epilachna similis. (C.N. Smithers): A severe outbreak of maize ladybird occurred and in some areas extensive damage was done to well grown maize. The insect proved unexpectedly difficult to control with the commonly used insecticides.

The main outbreak occurred on maize in the Norton area in January. The insects concerned were the adults of a generation which had developed on *Eleusine* in the vicinity of the maize.

Two spraying trials were attempted. The first, at Norton, was interrupted by a heavy downpour of rain. The second, at Beatrice, was satisfactorily concluded and indicated that toxaphene, dieldrin and malathion were satisfactory insecticides. No data on dosages of dieldrin emulsion which could be used as a foliage spray were available so an arbitrary dosage of 1:24 of 19.5 per cent. emulsion was used and applied at 12 gallons per acre.

Malathion, at 1½ pints of 50 per cent. emulsion, would appear to be the most economical insecticide for use against *E. similis*.

(Rhodesia Agricultural Journal, Vol. 56, No. 3, May-June, 1959.)

ST. HELENA

Citrus: The chief pests of citrus trees on the Island are the citrus psyllid (*Trioza erytreae*), which galls the leaves, and the aphis which form dense colonies on the terminal growth. Against *Trioza* and aphids on young citrus trees good results were obtained by spraying with malathion emulsion and Agral LN, applied from a knapsack pump.

Onion thrips: Spraying with 0.1% DDT (emulsion or wettable powder) gave good results.

Other pests

Red spider mite, *Tetranychus* sp. *telarius* group: Sulphur and hydrated lime, finely ground and thoroughly mixed in equal proportions by weight gave a very satisfactory kill of red spider in local beds of French beans, egg-plant and various garden flowers. This dusting mixture is now prepared and sold at Scotland Station.

Brevicoryne brassicae: Experimentally this pest was found to be readily controlled by repeated sprayings with (a) DDT emulsion (b) nicotine sulphate with Agral LN wetter or (c) a suspension of Plant Protection Ltd's. "Katakilla" powder, of which the active ingredient is rotenone. In other field work unconnected with this particular experiment a single application of lindane 1% dust gave such excellent control of this pest that a second application was not needed.

(Annual Report of the Department of Agriculture and Forestry, 1958.)

SEYCHELLES

Coconut: The first tour of treatment of all coconut palms on the island of Praslin, under the *Melittomma* Control Scheme, was completed by the 31st January, 1958, in the course of which some 58,585 palms were treated, using paradichlorobenzene as a fumigant and some 13,473 palms were felled. A survey following these measures indicated a large reduction in the *Melittomma* population. Two new coconut pests were recorded in the Colony in 1958 - the long-tailed mealy bug, *Pseudococcus adonidum* on Poivre and Darros islands, and the scale, *Lopholeucaspis cockerelli* on Alphonse island.

Citrus

Collection and distribution of coccinellid predators of scale insects and parasites of the citrus black fly were effected on several occasions in 1958. The former were shipped mainly to Poivre and Alphonse islands, especially to the latter where severe infestations of the scale insect *Eucalymnatus tessellatus* Sign occurred. The citrus black fly parasites were distributed on Mahé and other granitic islands.

(Annual Report of the Agricultural Department, for the year 1958.)

SIERRA LEONE

Malaria: Mr. R. Elliott, Entomologist of the Malaria Service of the Federal Medical Service of Nigeria visited Sierra Leone to survey and report on the present status of entomological control of malaria in Freetown. The survey was financed by the West African Council for Medical Research.

In an investigation into susceptibility of local *A.gambiae* to B.H.C. and D.D.T., Mr. Elliott found that resistance of larvae obtained at Wellington to D.D.T. was higher than any so far examined in the Lagos Laboratories, but he noted that no true resistant strain to D.D.T. had been found anywhere. The resistance to D.D.T. in *A.gambiae* larvae from Wellington was measured and the L.C. 50 value obtained was 1.9 parts per million as compared with 150 and 25 ppm. respectively found for resistant larvae of *A.stephensi* and *A.sundaicus*. He concludes that the Wellington *A.gambiae* while more tolerant to D.D.T. than most *A.gambiae* elsewhere have not developed anything like a true resistance and after twelve years of exposure to D.D.T. have probably gone as far in the direction of resistance as they are likely to go.

No changes have yet been made in the methods of mosquitoes control employed. Considerable reliance is still placed on residual spraying particularly in the sub-urban and rural areas. Houses in these areas are treated quarterly with B.H.C. but in view of Elliott's report a change in methods must be considered.

(Report on the Medical and Health Services for the year 1957.)

TANGANYIKA

Tsetse Control: A small focus of *Trypanosoma gambiense* infection occurs at Kagunga on the shores of Lake Tanganyika, 30 miles north of Kigoma. *Glossina palpalis* habitats on the shore were sprayed with dieldrin (5% Dieldrex), with a view to eradicating the fly. The application has been very successful, though later surveys have shown a few places where a second application was required. In some cultivated areas 2% Dieldrex was used. In the Chimpanzee Reserve, DDT (Arkotine) was used lest the chimpanzees were affected by dieldrin.

(Annual Report of the Sleeping Sickness Service, Medical Dept., 1958.)

TRINIDAD AND TOBAGO

Malaria Control

Residual Spraying: During the year 1958 dieldrin was substituted for DDT throughout Trinidad and Tobago. This programme was carried out in spite of the fact that *Anopheles aquasalis* was resistant to dieldrin according to the modified Busvine-Nash technique with WHO test kits, for two reasons:

1. Wall tests carried out showed adult *aquasalis* mortalities between 80-100% on walls treated with 0.6 g of dieldrin per sq. m. (normal rate of application in routine house spraying).

2. Residual spraying with dieldrin in Trinidad and Tobago was the sole weapon available for the eradication of *Aedes aegypti*.

It is felt that this programme has been completely justified as *Aedes aegypti* is now virtually eradicated. Houses in Tobago have been similarly treated.

Bromeliad Malaria: The spraying of host plants of *A. bellator* and other plants with copper sulphate and their manual removal, wherever necessary, was satisfactorily carried out in the Sangre Grande, Fishing Pond, La Serva and Matura areas during the year.

(Health Department, Malaria Division, Annual Report 1958.)

Cacao

Spraying trials were continued at Perseverance Estate to test the value of low volume spraying with Perenox, at intervals of four and six weeks, to control black pod and witches' broom. Results indicate that regular sprayings, where black pod is severe, will give an increase of 200 lb. of dry cacao on clonal material.

Against leaf eating beetles, Cetonia arcuata, on young clones, a mixture of BHC, linseed oil and Teepol gave complete control.

Banana

Leaf Spot Disease (causative organism Mycosphaerella musicola): Experiments at the Central Experiment Station have demonstrated that low volume, oil based sprays are more efficient and cheaper than high volume, water based sprays in the control of this disease. Experiments have also demonstrated that the oil has fungistatic properties, and reduces the development of spots in leaves which have already been infected. There is also an indication that it is possible, under certain conditions, to control the disease by the use of oil alone without the inclusion of a fungicide.

Borer Weevil, Cosmopolites sordidus, Germ.: Preventive treatment before planting by paring away infective material and immersing suckers in a solution of aldrin, together with treatment after planting by spraying round the base of plants at six monthly intervals with dieldrin were recommended. It was found that the application of a low quantity of high concentration dieldrin gave better control than a high quantity of low concentration dieldrin, which is the favoured treatment in other countries.

Other Pests: It is thought that the recommended treatment for Cosmopolites would also help considerably to reduce hard back beetle, Lygynus ebenus and rhinoceros beetle, Strataegus anachoreta, which burrow into the suckers. The boring caterpillar, Castnia licoides, which is normally a pest of sugar cane, attacked the central stem of bananas. Control was suggested by dieldrin spraying, at more frequent intervals than for the borer weevil, application being made higher up the plant.

Coconut

Red ring disease (causative organism Aphelencoides cocophilus) was studied by Dr. D. W. Fenwick, Nematologist from Rothamsted. He concluded that the main source of infection of the disease was from the soil and that the nematodes entered the stem through the roots. Weevils, in his opinion, were only of minor importance in the spread of this disease. Nevertheless, he expressed the view that they might be a major pest in their own right, as a weevil attack was probably fatal whether red ring was present or not. He also pointed out that infection might occur by way of seed nuts; as several drop nuts, which were being used for planting, were found to contain soil nematodes and three of these also contained A.cocophilus.

Pineapple

Control measures for pineapple wilt disease (caused by the mealy bug, Pseudococcus brevipes (Cockerell)) appear to be the eradication of the associated stinging ant, Solenopsis germinata,F., by spraying with aldrin and treatment of planting material, before establishment, by immersion in a suspension of parathion to eliminate the mealy bug.

Sweet Potato

Promising control of the moth borer (Megastes grandalis Gn) was achieved by using aldrin or dieldrin. More frequent application at a higher concentration was emphasised for next year's experiment.

Stored Rice

An efficient method appears to have been evolved for storage of paddy at the Central Experiment Station. The walls are sprayed with a mixture of BHC and DDT and the paddy was treated, immediately before it was bagged, with lindane dust. In addition, the outside of the bags were dusted as the stacks were made.

(Administration Report of the Agriculture Department for the Year 1956.)

UGANDA

Tsetse control: Control operations with insecticide continued to be attended by marked success in 1958. In the north Lango sleeping sickness area, where G.palpalis was virtually eradicated from rivers and streams in 1957 with the use of dieldrin, control was successfully maintained. This was done by regular spraying, with dieldrin every two months, of barriers on all the likely avenues of reinfestation, i.e. the five major rivers, around the periphery of the treated area. Although the number of cases of benign gambiense sleeping sickness reported was 230 as compared with 250 in 1957, it was generally agreed by all concerned that, in view of the high degree of vector control achieved, it was most unlikely that more than a very few, if any, of the new cases in 1958 became infected after the establishment of control measures in October, 1957.

A spraying operation to eradicate a residual focus of G.brevipalpis along a seven-mile stretch of the west bank of the River Nile in Bugerere County, Mengo, was staged towards the end of the year.

In December a further spraying operation was begun in the adjoining parts of Aringa and Terego counties in West Nile District where a comparatively limited endemic focus of gambian sleeping sickness appeared to persist. The initial spraying carried out covered a 10-mile stretch of the River Datcha.

Malaria: The incidence of malaria in 1958 remained unchanged. Plans were framed for a malaria compaign in the Kigezi District following a visit there by a W.H.O. team which recommended that a control scheme was feasible. The team will attempt to break malaria transmission and the first spraying is planned to take place in the first half of 1959.

Onchocerciasis: The results of the attempted eradication of Simulium neavei on Mount Elgon were disappointing. Although the number of flies was considerably reduced, eradication obviously failed. However, it was noted that the fly population remained at a considerably lower level.

The Uganda Electricity Board decided to construct a hydro-electric scheme near the Karuma Falls on the Nile between Atura Ferry and the Murchison Falls and a survey of the area disclosed a heavy infestation of Simulium damnosum. Plans were accordingly made to dose the river before construction work commences early in 1959. A plastic perforated pipe will be slung between a pylon on each bank and D.D.T. will be introduced into the river through this.

No attempts were made to deal with Simulium on the eastern slopes of the Ruwenzori.

Virus research: The acquisition of a steel tower, 120 feet high, allowed work of a new type to be undertaken. For many years the important mosquitoes of the forest canopy have been studied but the tower made it possible to begin work high above it. Considerable activity by both male and female mosquitoes and by gadflies in this zone above the roof of the forest was revealed. This is of importance, as it is from this level that the dispersal of disease-carrying mosquitoes is most likely to take place. Another finding of major importance was that, in one species at least, the older female mosquitoes - those most likely to be infected - form a much larger proportion of the population at the upper levels.

(Report for the year 1958)

Banana: As the result of trials conducted on the control of banana weevil, *Cosmopolities sordidus*, a simple and inexpensive method of control was evolved using 0.5% dieldrin dust, and a start was made applying the method in the field.

For an account of this work see East African J., 1957, 23, 110-112.

Maize: Early maturing and rust resistant maize is unusually susceptible to leaf blight, *Helminthosporium turcicom*. Selection for resistance to this disease has only just begun, but meanwhile a partial control has been found with the organo-sulphur-zinc chemical zineb. The Muratha increased yields from heavier cobs ranged from 28% to 50% of controls and in K.8 and A.F.R.O. 53200 from 39% to 184% of controls due both to more and heavier cobs.

Sorghum: In Karamoja where it is usual to find up to 20% sorghum heads diseases with smut, *Sphacelotheca sorghi*, complete control and increases in stand were obtained by using seed dressed with "Fernasan D" (= 20% gamma BHC + 25% thiuram).

Cotton: A series of 100 plots was laid down, mainly in the S.47 area, to test on a farmer's plot scale, the most likely insecticidal control for *Lygus*; the spray treatment was 1 lb. DDT per acre for four applications spaced at ten-day intervals. Yield increases of seed cotton ranged from 110-314 lb./acre. The minimum economic increase is about 130 lb./acre.

Miscellaneous Pests: A 1% solution of dieldrin is found to give good protection to wood against *Xylocopa* spp. for at least ten months. 0.5% dieldrin dust has been used successfully against various termites.

Endrin at 4 oz. per acre was found to give a high percentage (90%) kill of aphids on cotton; the same insecticide also gave excellent control of spiny bollworm (*Earias* spp.) on cotton, applied at 8 oz. per acre.

Malathion was found to give good control of the maize tassel beetle, *Megalognatha rufiventris*, and of aphids on citrus, at $\frac{1}{4}$ pint 50% emulsion, in four gallons of water. Malathion with banana bait successfully controlled fruit flies, *Drosophila* spp. occurring in large numbers in some houses.

Pests of Stored Produce

Maize - Crib Storage: Two trials were completed, on the influence of husks on storage and the use of BHC powder. Tight shucks protect the maize for three to four months before infestation becomes serious, and do not greatly affect the drying rate. Eight oz. of 0.5% BHC per nine cu. ft. of cobs (200 lb.) gave excellent control of rice weevil, Calandra oryzae. A trial is in progress comparing full versus half dosage; meanwhile the rate given above is being recommended as standard procedure for maize protection.

Beans - Drum Storage: Very good results were obtained using 8 oz. of a 0.04% BHC dust to 200 lb. of beans stored in iron drums. Almost complete protection was achieved over a period of six months.

Treatment of Stores: 50% DDT (wettable powder) at a dosage of 8 oz./1 gal. water/1,000 sq. ft. wall surface, has been found remarkably persistent under Uganda conditions, good kills of Calandra occurring even after twelve weeks; the experiment is being continued. Experiments were started using an insecticide in a whitewash base.

Coffee Root Mealybug

A series of trials was carried out in Bugisu, using a range of insecticides as both liquid and powder. "Agrocide 7" and 2.5% lindane (pure BHC) dust, proved the most effective control with 2.5% and 1.5% aldrin dust second. Because of the risk of tainted liquor with a crude BHC product, 2.5% lindane dust has been advised as the standard control.

(Annual Report of the Department of Agriculture for the Year ended 31st December, 1957.)

NEWS ITEMS FROM OTHER PARTS OF THE WORLD

POLYNESIA

Control of Filariasis

"In achieving our objective of control of filarial disease, it is not the eradication of the vector mosquito that is necessary, nor even the eradication of the parasite in man, but the breaking of the chain of close association of high vector densities with man.

To a large extent the prevalence of vector mosquitoes in the vicinity of habitations is due to man-made causes. The *Aedes* mosquito breeds mostly in containers such as cisterns and barrels for storing fresh water, coconut shells and discarded food tins in which rain-water collects. While water containers breed the mosquito all the year round, the discarded coconut shells and food tins step up *Aedes* production during the rainy season, and for several months after.

Thus it becomes apparent that control of filariasis in South Pacific islands is merely a matter of carrying out simple village sanitation measures, essentially the elimination, or proper protection, of domestic rain-water containers, and removal of all coconut shells and discarded tins.

Elimination of Rain-Water Containers: Provision of a piped water supply - possible on many islands by tapping streams or sub-soil water - would eliminate the need for domestic water containers. As an alternative for low-lying atoll islands, large rain-water catchments could be erected, or the roofs of existing church buildings utilized and the water stored in mosquito-proof cisterns and tanks. Domestic water containers, if these cannot be entirely eliminated should be of a standard design and provided with proper lids.

Disposal of Shells and Tins: The collection and disposal of coconut shells and discarded tins within the village, and for about 120 yards around it, is a matter which could well be carried out by the people themselves. It would, however, need stimulation through educative propaganda and the full-time attention of a filariasis control inspector appointed to co-ordinate and direct the efforts of the villagers. This procedure would not be new to Pacific islanders, most of whom observe village "clean-up days" at periodic intervals. What is needed is to stimulate, co-ordinate, and direct public effort.

The two measures suggested above offer more permanent results in filariasis control in the South Pacific islands than any other method I know. They also offer collateral benefits such as an adequate and protected water supply, village cleanliness and freedom from day-biting mosquitoes."

("Combating Filariasis in Polynesia". M.O.P.Iyengar, South Pacific Commission Quarterly Bulletin, Apr. 1959, 9, (2), 51-55.)

PHILIPPINES

Coconut: In the Philippines the gradual effect of the more rapid spread of the yellow mottle decline (kadang-kadang) disease of cocunut may well slow down the rate of expansion achieved in the last few years, and temporary factors such as dry weather and typhoon damage would consequently have a more marked effect on export volume stability. Over the next decade the ravages of the disease, which may now be threatening the heavy tree population in Quezon Province, may become the most important factor in the Philippines export economy.

(Coconut Situation, I, p.4, May, 1959, F.A.O.)

ABAVIT B (United Kingdom)

British Schering Ltd., 229/231, Kensington High Street, London, W.8.

Organo-mercurial seed dressing for use on wheat, barley, oats and rye, for the control of seed borne diseases (see below) and to afford some protection against fungi and bacteria, particularly under conditions of slow germination.

"Abavit B" is described as a pink, free-flowing, dustless powder containing an improved, water-repellent base, affording exceptional covering and adhesive properties and not causing rusting of seed dressing machinery.

Any method which ensures a thorough and even coating of the seed is suitable for its application. An automatic machine is indicated for treating large quantities; for smaller amounts a clean closed barrel, rolled or rotated for a few minutes. Seed required for storing, dressed or otherwise, should be of low moisture content and kept in a dry, draught-free place.

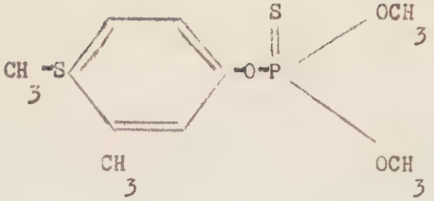
Quantities to use

Crop	Disease	Amount of abavit B			
		% by weight	oz. per bushel	oz. per barrel	oz. per cwt.
Wheat	Bunt (or stinking smut)	0.2	2	8	4
Barley	Leaf stripe Covered smut Net blotch	0.2	2	8	4
Oats	Leaf spot Covered smut Loose smut	0.3	2	8	5½
Rye	Stripe Smut Partial control of pre-emergence blight	0.2	2	8	4

Because of the toxic nature of its active ingredient "Abavit B", in common with other mercurial formulations, must be handled with discrimination. Further particulars of this and other compositions are available from the manufacturer.

BAYER 29493 (S.1752)
Farbenfabriken Bayer, Leverkusen

Broad spectrum insecticide containing as the active principle 0, 0-dimethyl-0-4-(methyl mercapto)-3-methyl phenyl thiophosphate. The latter is a brown liquid with an odour of garlic, soluble in most organic solvents, practically insoluble in water. Resistance to light and to mild alkali (up to pH 8), coupled with low vapour pressure qualify it for application as a residual insecticide for house spraying against flies and mosquitoes.



Physical Data

Sp. gr.	1.25
Refractive index n 20/D	1.5698
B.p. (0.01 mm Hg)	105°C
Vapour pressure 20°C.	$2.15 \times 10^{-}$ mm Hg
Acidity % wt. (as H_2SO_4)	0.2-0.3
Water content % wt.	0.3-0.5
Volatility at 20°C.	0.04 mg/cbm
30°C.	0.12
40°C.	0.39

Toxicology: MLD 50 rat per os 200-220 mg/kg. No resorptive phenomena of poisoning when applied percutaneously (four hours direct application onto a rabbit's ear using a cotton wool plug). Rabbits, rats and mice exposed to 1 cc atomised per cu m of space for two hours showed no trace of poisoning or irritation, (cholinesterase inhibition 0.005 cc/kg when administered chronically for three days. Its safety factor to fish related to mosquito larvae effect is 1000 (10 ppm causes 100% mortality Lebistes reticulatus in 24 hours).

Formulations: The following are available:

20% wettable powder (4894)	For residual spraying against mosquitoes, flies and bedbugs.
2% granular (4910)	For the control of mosquito larvae.
50% emulsion (4895)	For the control of agricultural pests.
20% in oil (4942)	For spraying against migratory locusts.
40% wettable powder (4894a)	For residual spraying.

Biological effectiveness: Some preliminary results are given in the accompanying table.

Some Tests Results with Bayer 29493

Test Insect	Stage	Dosage rate	Result
Aedes aegypti L.	larval	0.01 ppm	100% kill within 24 hours
Anopheles subpictus nom. (160 x dieldrin resistant)	imaginal	0.1 g/sq.m filter paper	100% kill in 2 hours
Culex fatigans (4 x DDT resistant)	larval	0.01 ppm	100% kill in 24 hours
Musca domestica L.	larval	1.0 ppm	100% kill within 72 hours
Chrysomyia putoria (chlorinated hydro-carbon and diazinon resistant)	larval	< 5.0 ppm	100% kill within 24 hours
Rhodnius prolixus		0.05 g/sq.m. filter paper	100% kill within 24 hours
Cimex lectularius L.		0.005 g/sq.m filter paper	100% kill within 24 hours
Blatta oritentalis L.		0.05 g/sq.m filter paper	100% kill within 24 hours
Gryllus domesticus L.		0.005 g/sq.m filter paper	100% kill within 24 hours
Calandra granaria L.		0.05 g/sq.m filter paper	100% kill within 24 hours
Locusta migratoria migratorioides		0.05 g/sq.m filter paper	100% kill within 24 hours

TERMITE CONTROL WITH CHLORDANE

Velsicol Interational Corporation, 330, East Grand Avenue, Chicago II, Illinois.

It is remarked that subterranean termites were last year responsible for damage estimated at 40 million dollars.

The suggested control procedure is to apply ½ to 1% chlordane water-emulsion sprays to the infested soil areas with low pressure spraying equipment. Sufficient quantities of liquid should be used to insure thorough soaking of the area. As a general rule, sandy soils require the least amount of insecticide, clays and loams slightly more, with peats and mucks requiring the most.

Where outside trenching operations next to foundation walls are desired, it is usually advisable to dig the trench 1 to 2 ft. deep and 8 to 12 in. wide. Here, again, a ½% to 1% water emulsion chlordane spray should be used and applied at the rate of one gallon per linear foot of trench. It is also desirable to treat the soil as the trench is being re-filled.

The maximum residual effectiveness has not been established since these evaluations are still in progress. However, present results show the protection period to be at least five years.

'MURPHEX' RODENT AND INSECT CONTROL HANDBOOK
3rd Edition 1959, pp.92.
Murphy Chemical Co. Ltd., Wheathampstead, Nr. St. Albans, Herts.

Revised and enlarged edition of the handbook first published in 1952.

ORGANO-TIN COMPOUNDS
Pure Chemicals Ltd., Kirkby Industrial Estate, Nr. Liverpool.

Provisional leaflet, outlining potential uses for these compounds, as, for example, the stabilisation of resins such as PVC, catalysis, and protection against attack by micro-organisms.

A good report is given of tri-alkyl and tri-aryl tin compounds for preserving oil or emulsion based paints or as auxiliary agents in controlling slime in paper mill systems. It is suggested that their use should be further explored for the preservation of wood, textiles and adhesives, and as crop fungicides. Tri-phenyl tin acetate is promising for the control of potato blight and leaf spot in sugar beet and celery, its use having resulted in increased yields, (80-100% reported for sugar beet).

Toxicity of the organo-tin compounds is inversely proportional to the length of chain of the alkyl group. Tri-ethyl tins are highly toxic; tri-n-butyl tins are reported to be about 40 times safer than phenyl mercury acetate and 2-3 times safer than pentachlorophenol based on oral administration (10 times lower than PMA by dermal route).

Some of their properties are listed in the accompanying table.

PROPERTIES

PRODUCT	FORM	% TIN CONTENT	SP. GR. @ 20°C.	SOLUBILITY			
				WATER	ALCOHOL	BENZENE	HYDROCARBONS
Di-n-Butyltin di Acetate	Colourless to pale yellow liquid. SP.10°C.	33.8	1.32	NS	RS	S	S
Di-n-Butyltin di Chloride	Yellow to light brown crystalline solid. SP.35°C.	39.0	-	NS	RS	S	S
Di-n-Butyltin Oxide	White to pale cream powder	47.7	-	NS	NS	NS	NS
Tetra-n-Butyl tin	Pale yellow liquid	34.2	1.052	NS	NS	S	S
Tri-n-Butyltin Oxide	Pale yellow liquid	39.8	1.16	<0.1%	RS	RS	RS
Tri-n-Butyltin Acetate	White, waxy solid	34.0	-	NS	RS	RS	RS
Tri-n-Butyltin Laurate	Yellow liquid	24.25	1.05	NS	RS	RS	RS
Tri-n-Butyltin Naphthenate	Brown, viscous liquid	19.3	1.065	NS	RS	RS	RS
Tri-n-Butyltin Resinate	Very viscous brown liquid	16.1	1.11	NS	RS	RS	RS
Di-n-Octyltin Oxide	Cream powder	32.9	-	NS	SS	SS	SS
Tetra-n-Phenyl tin	White to cream powder	27.7	-	NS	MS	SS cold S hot	SS
Triphenyltin Acetate	White to cream powder	28.9	-	NS	S	S	SS
Triphenyltin Oxide	White to pale yellow crystals	33.2	-	NS	S	SS	NS cold

NS = Not soluble
S = Soluble
RS = Readily Soluble
SS = Slightly Soluble
MS = Moderately Soluble

"OTTACIDE P"
Ottawa Chemical Co., 823, Hamilton Street, Toledo 7, Ohio.

Derivative of para-chlorometa-xylenol, possessing marked fungicidal and fungistatic effectiveness, for incorporation in semi-rigid and flexible polyvinyl chloride compounds. The material is a white powder, passing 50 mesh, with a slight phenolic odour. Sp. gr. 1.4;

melting range 125-145°C.; boiling range over 260°C. It can be compounded with the fluxed compounds (by preblending and open milling) or as a plastisol, (by preblending and grinding on a paint mill), or in solutions, (facilitated by its high solubility in methyl ethyl ketone and other plasticisers).

It is indicated for use in the ratio of 0.5 to 1.0% on a supported vinyl compound, or 1.3% on total weight in a clear vinyl compound.

The heat history both of clear films or dead white coated fabrics is not affected by the fungicide, confirmed both by prolonged milling at 350°F or by oven aging up to 90 minutes in a convection oven at 350°F.

The light aging checked by exposures in a Fade-O-Meter and weathering unit X-1-A has shown both in clear films and opaque compounds an unchanged condition both in colour and flexibility for over 500 hours.

ROGOR

Fisons Pest Control Ltd., (Chesterford Park Research Station, nr. Saffron Walden, Essex.
Extracts from Newsletter No. 2.

Onion Fly Control

The Onion Fly (Delia antiqua) has become resistant to dieldrin in the United States and Canada and experimenters are trying many insecticides to control this resistant strain. Outstanding control has been obtained with dimethoate and diazinon in work reported by Guyer and Wells in the February 1959 Quarterly Bulletin of the Michigan State Agricultural Experiment Station.

Pine Shoot Moth

In the same report, other workers (Butcher and Haynes) show the value of dimethoate for control of Pine Shoot Moth (Evetria buoliana) on red pine. The equivalent of 5 pints of Rogor 40 per 80 gallons of water gave excellent control and was equal to DDT at 2 lb. per 80 gallons. The authors think this may be of considerable interest in aircraft and mist-blowing application, where the efficacy of DDT is in question.

"658" FUNGICIDE

Miller Cehmical & Fertiliser Corp., 2226, N. Howard Street, Baltimore 18, Maryland, U.S.A.
(Crag licensee).

Green-yellow, free flowing powder of very low water solubility containing 95% of a copper-zinc-chromate complex 15 CuO, 10 ZnO, 6 CrO_3, 25 H_2O. It is readily suspended in water without the addition of wetting or dispersing agents or can be formulated as a dust by dilution with an inert material such as talc, pyrophyllite or clay. Spray or dust deposits on foliage are resistant to weathering and the compound is chemically stable both in storage and on foliage. The compound is compatible with a wide variety of insecticidal and fungicidal combinations.

Toxicology: "658" Fungicide has a low order of toxicity to warm blooded animals. It is exempt from tolerance by the Federal Food and Drug Administration and can be used within one day of harvest without danger of residue on the crop. The single oral dose LD-50 of "658" Fungicide to rate is 6.16 gm/kg. It exhibits little accumulative action and has a low order of primary irritation on the skin, mucous membrane, and cornea of rabbits. It is safe to handle without apecial protective equipment but inhalation of dust should be avoided.

Uses: Details of the applications for which it has been registered with the USDA are given in the accompanying table.

"658" Fungicide

HOST	PATHOGEN	DOSAGE RATES *	DETAILS OF APPLICATION
Potatoes	Early and late blight	1-2 lb. "658" per 100 gal. water or 30-40 lb. of 6-8% dust to each acre.	Apply with conventional spray equipment at rate of 125 to 150 gals. per acre at intervals from 7 to 14 days depending upon weather conditions and disease incidence. Under conditions which favour blight development, more frequent applications are required than during dry, hot weather. Begin spraying soon after potato plants show above ground. Continue throughout the growing season. Apply with conventional dusting equipment at the same intervals as for spray application.
Tomatoes	Early blight, late blight and *Septoria* leaf spot	2-3 lb. "658" per 100 gal. water	Apply spray or dust as described for potatoes.
Cucurbits	Downy mildew, anthracnose, scab and *Miscrosporium* leaf spot.	2 lb./100 gal. water.	Apply spray or dust as described for potatoes.
Peanuts	*Cercospora* leaf spot	Use dust blends of "658" Fungicide and sulphur in accordance with recommendations of your local or state agricultural authorities. To make a dust blend blend, use 5 lb. of "658" Fungicide thoroughly mixed with 95 lb. of conditioned dusting sulphur. 5 lb. of 50% DDT wettable powder or any of the approved insecticides may be added for insect control. Apply dust at 20 to 30 lb. per acre. The first application should be made when the leaf spots first appear. Two or three additional applications should be made at two-week intervals, depending upon the severity of the leaf spot and the weather conditions.	
Citrus Fruits	*Phytophthora* brown rot *Botrytis* blossom blight	2 lb/100 gal. water.	The addition of a suitable spreader-sticker aids disease control. Apply sprays in accordance with local recommendations.
			Apply sprays in accordance with local recommendations
Avocadoes	*Botryosphaeris ribis* (*Dothiorella* rot)	2 lb./100 gal. water	
Azaleas	Petal blight	2 lb./100 gal. water.	The first application should be made soon after the young leaves appear. Additional sprays should be applied every 5 to 7 days depending on weather conditions and severity of the blight. Remove and destroy diseased blossoms.
Turf	Brown patch, dollar spot and snow mould	1-1½ lb./50 gal. water. or as dust prepared by mixing 1 part with 30 parts by wt. finely ground agricultural lime	Apply 1 gal. of dilute spray to each 150 to 200 sq. ft. Apply dust mixture at rate of 10 lb. to 2000 to 3000 sq. ft. or 150 to 200 lb. per acre.

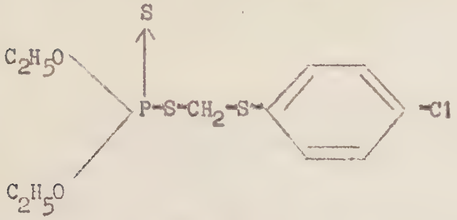
* Notes (1) Suspensions require continuous agitation. (2) Dosages relate to U.S. gallons.

TRITHION

Stauffer Chemical Co., Agricultural Research Laboratory, P.O. Box 757, Mountain View, California.

Physical and Chemical Properties: Technical grade Trithion is a light amber liquid containing about 95% of the insecticide/acaricide 0,0-diethyl S-p-chlorophenylthiomethyl phosphorodithioate. Solubility in water is less than 2 p.p.m. at 20°C. Miscible with most organic solvents including n-hexane, xylene and the common alcohols, ketones and esters. Compatible with kerosene and mineral oils.

Sp.gr.$\frac{20^\circ}{20}$C. is 1.265-1.285.



Refractive index n_D^{25} is 1.590-1.597. Relatively stable in water at room temperatures over wide pH range. Its vapour pressure is extremely low.

This material differs from certain other OP compounds in that it is stable under highly alkaline conditions and can be used with lime and lime sulphur. It is compatible with most spray and dust materials likely to be used at the same time and with all diluents and surfactants that are suitable for parathion and other OP insecticides. A ten day interval is suggested between application of dinitro compounds (e.g. Karathane) and Trithion to avoid plant injury. In general commercial field experience with Trithion indicates a mild phytotoxity problem which is similar to that of other well known organophosphorus compounds, associated with meteorological conditions that delay evaporation of moisture from the plant surface during and immediately following the application of sprays. There is no record of phytotoxicity resulting from Trithion dust applications.

Slight injury to fruit and foliage has occurred on certain varieties of apples especially in the Eastern and Mid-western areas of the United States. Injury has occurred in certain cases when pink and petal fall sprays have been applied. No injury has resulted from dormant or delayed dormant sprays. Applications of three or more successive sprays at one or two week intervals in the cover spray schedule have, in some cases, caused foliage injury to certain varieties. In these areas no significant injury has resulted from single applications at a mite control dosage applied after the second cover spray.

Isolated cases of Trithion phytotoxicity have been reported on roses grown under glass and citrus. Elevated dosages and formulation problems may have been responsible for this injury.

Where conditions are favourable for phytotoxicity, the use of wettable powder formulations is suggested. Additives such as proprietary soaps and detergents may aggravate the phytotoxicity problem with Trithion sprays.

Organoleptic studies conducted by independent panels have indicated no taste problem on apples, peaches, pears, tomatoes and tobacco. Experiments conducted by the Research Department of the Stauffer Chemical Company have indicated no problem of off flavour for any fruit and vegetable crop on which Trithion has been applied.

Pesticidal activity: Trithion is characterised as a non-systemic compound having comparatively long residual effectiveness. It possesses little, if any, fumigant activity. It has been tested extensively under the code designation of Compound R.1303 and found effective against a wide range of insect and mite species on a variety of crops under typical field conditions. It is highly active against the eggs and post-embryonic forms of certain species, such as the European red mite (Metatetranychus ulmi) and the apple aphid (Aphis pomi), and against both summer and winter eggs of the European red mite. Trithion is slightly less toxic than DDT to the honey bee and considerably less toxic than parathion to a broad range of insect parasites and predators.

The following pest control problems are suggested to investigators as those offering greatest promise for the use of Trithion:

(1) For control of armoured and unarmoured scale insects by incorporation with spray oils.

(2) In "clean up" sprays for deciduous fruit orchards applied either post harvest, dormant or delayed dormant. Trithion shows particular promise for this problem because of its high activity against a wide range of pests including over-wintering mite and aphid eggs and scale insects. Appropriate spray oils when used with Trithion increase its effectiveness for this use.

(3) For control of spider mites, aphids, mealybugs, leaf-hoppers, and other motile homopterous insects on various ornamental, food and fibre crops with dust spray applications. Trithion is well adapted for application by airplane and by power and manually operated ground equipment.

(4) As a substitute for more hazardous organophosphorus pesticides where the use of such materials is restricted by legislation and other considerations.

Formulations available: Dusts containing 1, 2, 3 and 4% Trithion; Trithion 25-W (25% wettable powder); Trithion 4 Flowable (4 lb./gal. aqueous emulsion); Trithion 4-EK (4 lb./gal. aliphatic base solution containing surfactants that do not adversely affect the depositing characteristics of conventional oil spray products). Special formulations for experimental purposes will be manufactured for qualified investigators on request.

Application:

(a) Dilute orchard sprays: One-fourth to one-half pound of technical Trithion per 100 gallons where mites, aphids, leafhoppers and other highly susceptible pests are involved. For control of armoured scale insects a dosage of ½ lb. to ¾ lb. of technical Trithion per 100 gallons is suggested. As an oil additive a dosage of ¼ to ½ lb. of technical Trithion dissolved in 1 to 2 gallons of an appropriate oil per 100 gallons of spray is suggested.

(b) Concentrate orchard sprays and dusts: One pound of technical Trithion per acre is suggested as a minimum requirement for control of orchard mites and highly susceptible insects. In the case of the citrus red or the purple mite (Metatetranychus citri) where a control period of several months is required the use of 2 to 3 lbs. of Technical Trithion per acre is advisable.

(c) Sprays and dusts for field and vegetable crops: A dosage of ½ to 1 lb. of technical Trithion per acre depending upon the susceptibility of the pest involved is indicated.

Toxicology: Mammalian toxicological investigations on Trithion have been conducted by the Hazleton Laboratories of Falls Church, Virginia. A summary of their findings follows:

Acute Oral Toxicity:

A. Male albino mice LD-50 = 218 mg./kg.
B. Male albino rats LD-50 = 30 mg./kg.

Acute Dermal Toxicity:

Albino rabbits by skin application LD-50 = 1270 mg./kg.

Inhalation Toxicity: Rats and dogs confined in a near saturated atmosphere of Trithion during a four week period exhibited no signs of toxicity. There was a slight reduction in the plasma cholinesterase of dogs, but there was no effect on the red blood cell cholinesterase level. There was no reduction in cholinesterase activity of either blood plasma or red blood cells of rats.

The foregoing data indicate that orally administered Trithion is highly toxic to mammals but that it is substantially less toxic by inhalation or skin absorption.

Although these latter forms of exposure are those normally encountered in field application, investigators are warned to use the same precautions in handling Trithion as they would for any new organic phosphate compound.

Analyses: Methods of analysis for the technical product, its formulations, and residues in or on agricultural commodities, are available from the manufacturer on request.

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ABSTRACTS

REPORT OF THE ROTHAMSTED EXPERIMENTAL STATION FOR 1958

Insecticides

Effect of Temperature on the Toxicity of Insecticides

The work started by Dr. Das on the effect of temperature on the toxicity of DDT to mosquito larvae was continued. Larvae of *Aedes aegypti* L. were exposed to DDT at 15°C and 25°C for short periods and then transferred to DDT-free rearing medium at 20°C for 48 hours. DDT had a significantly greater effect on larvae exposed at 25°C than at 15°C, which together with the results of Das, indicates that mosquito larvae pick up more DDT at the higher temperature.

Synergists for Pyrethrum

Four substances have been claimed to activate pyrethrum extract: piperonyl butoxide (3:4-methylenedioxy-6-propylbenzyl *n*-butyl diethyleneglycol ether), "Sesoxane" (2-(2-ethoxyethoxy) ethyl-3:4-methylenedioxyphenyl acetal of acetaldehyde), "S.421" (octochlorodipropyl ether) and "B.P.50" (diphenyl methane). The synergism of these substances was tested by a measured-drop technique, at fixed ratios with pyrethrum, on 5-6 day-old female houseflies with an after-treatment temperature of 20°C and an inspection time of 24 hours. Acetone was used as the solvent. The ratios of synergist to pyrethrins were 1:1, 1:2, 1:4, 1:8 and 1:20. "Sesoxane, piperonyl butoxide and "S.431" all increased the activity of the extract. "Sesoxane" had most activity, closely followed by piperonyl butoxide; S.421" was considerably less active. Diphenyl methane depressed activity, as also found with *Tribolium castaneum*.

To determine whether these materials act simply as synergists or whether they are insecticides, their toxicity when applied alone was tested. Another synergist, "Bucarpolate" (the ester of piperonylic acid with mono-*n*-butyl ether of diethylene glycol) was included: it was non-toxic 24 hours after dosing and $\frac{1}{2500}$ the toxicity of pyrethrin after 48 hours. "Sesoxane" had $\frac{1}{50}$ and piperonyl butoxide $\frac{1}{100}$ the toxicity of pyrethrum to houseflies, 24 hours after dosing. The flies were not knocked down by these compounds. "S.421" was fairly toxic, about $\frac{1}{10}$ the toxicity of pyrethrum; it also had a definite knockdown action.

Toxicity and Persistance of Insecticidal Deposits

A method for assaying toxicity of residual films of insecticide using adult *Musca domestica* L. was developed and is described in the next section. It permits short exposure times, whereas long exposures are necessary with adult *Tribolium castaneum* Hbst. Plates sprayed with a DDT emulsion consisting of 0.1% w/v DDT, 0.3% v/v xylene and 0.1% w/v lissapol N in water gave rather variable results, probably because of irregular crystallization. The plates increased in toxicity for at least 2 days after spraying. Plates sprayed with a solution of DDT in 78% v/v xylene, 20% v/v ethyl cellosolve (ethylene glycol monoethyl ether) and 2% v/v medicinal paraffin gave more reproducible results. The concentrations tested ranged between 0.05 and 0.5% w/v DDT, and with this formulation the film remained liquid on storage. This liquid paraffin formulation is more toxic on either plain of wax-coated plates than on cabbage leaves. The emulsion deposits, by contrast, are more toxic on leaves than on plates. A suspension of 60 µ needle crystals of DDT containing 0.1% w/v sulphonated lorol, 10% v/v ethyl alcohol and 90% water gives a more toxic deposit than the emulsion on both plates and leaves. These relative toxicities, determined with houseflies and exposure times of 2-8 minutes, may differ with other species and longer exposure times.

Bioassay of Contact Toxicity of Insecticide Deposits

In the bioassay method using adult houseflies (*Musca domestica* L.), the flies are chilled then sorted into batches of ten and allowed to recover. Each batch of ten is then exposed to the treated surface in an exposure chamber. The base of the chamber is perspex with a glass plate for the floor. The glass plate can be slid out and replaced by the treated surface. The side of the chamber is a metal ring cooled by circulating ice water to make it repel the flies. The top of the chamber is of perspex, with a hole for the introduction of the test insects. The exposure chamber is placed on a plate kept at 30-35°C and the glass plate on the floor allowed to warm to this temperature. The test insects are introduced and allowed to settle down on the attractive warm surface. The test surface, now at the temperature of the warm plate, is slid in to replace the glass plate as the floor of the chamber, and the flies settle on it. Ice may be placed on the roof of the chamber to make it repellent. After the given exposure time the flies are anaesthetized and removed to clean tubes. They are allowed to feed on sugar water during the 24-hour holding period at 20°C after which mortality is assessed.

Seed Treatment with Insecticides

Seed treatment with insecticides is a convenient and effective method of controlling some insect pests, and work was done on methods of formulating and applying insecticides to seeds and on their mode of action. One of the limitations of seed dressing is that relatively small amounts of active material will adhere to the seed unless special formulations are used, and various methods of applying liquid and solid insecticides were examined, using wheat and white mustard as test seeds. The stickers and fillers tested included aqueous emulsions of polyvinyl acetate and polystyrene, aqueous solutions of polyvinyl alcohol and methyl cellulose, polyethylene glycol, a siliceous earth, activated carbon and various proprietary insecticide fillers. Materials used in the formulation can affect the toxicity of the active ingredient, both to the insect and to the plant. Under some conditions both activated carbon and polyvinyl acetate depress the insecticidal activity of "Thimet", γ -BHC and dieldrin and decreases the phytotoxic effects of "Thimet" and γ -BHC. This may have considerable practical implications, because carbon is being used increasingly as a carrier for liquid organophosphorus insecticides. The possibility that the length of time the seed-dressing remains effective may be prolonged by means of materials in the formulation is being investigated.

Fungicides

Results of Spore-Germination Tests

(1) Evaporation: It is common practice when making spore-germination tests with fungicides to contain drops of spore suspensions in moist chambers on microscope slides. It has been assumed that the volume of the drop, and hence the concentration of the fungicide in the drop, will remain constant, but this is not so. Changes in volume of drops have been followed by measuring the change in concentration of a dilute solution of dye (Naphthalene Scarlet 4 RS). When Bottcher's slides containing 0.3-ml. drops are kept at a constant temperature, the volume usually decreases by about 7% in 48 hours. The size of the loss depends on the conditions, it may be as much as 47%; or water vapour from the water seal may even condense on the drop and increase in volume by about 5%.

(2) Loss of Mercury Compounds on Glass and Other Surfaces: Glass surfaces remove mercury from neutral aqueous solutions of inorganic mercury compounds. This may appreciably lower the nominal concentration of mercury in the course of spore-germination tests. The extent of these losses has been investigated. The proportion of mercury lost increases with time of contact with the surface, with the area of contact and with the degree of dilution. On microscope slides the losses

increase with increase in temperature in the range 10-25°C. The losses may occur during serial dilution of the solutions and on the microscope slides themselves. Thus, when a solution of mercuric chloride containing 60 mg Hg/litre is diluted in three stages to 1.0 mg Hg/litre in soda-glass tubes, the loss in strength of the final solution is about 25%. When 0.3 ml. drops of mercuric chloride solution, containing 1.0 mg Hg/litre, are placed on glass Bottcher's slides under cover-glasses, the losses are 15% in 15 minutes and 60% in 24 hours. The combined loss from both stages (tubes and slides) is over 70% in 24 hours. Cavity slides have been made from perspex and polystyrene sheet. The losses on perspex slides are almost the same as on glass; it is likely that the losses on polystyrene will be less.

The uptake of phenyl mercuric acetate by glass from neutral solutions is small. Thus, the loss on Bottcher's slides from 0.3-ml. drops containing 1.0 mg. Hg/litre is only about 7% in 24 hours, compared with 60% for mercuric chloride. The loss on perspex slides is about 35%.

Spores take up mercury rapidly from solution, so that in a spore germination test the mercury will be taken up by the spores and by the surface of the slide as well. The same may be true of other water-soluble fungicides.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING. ANNUAL REPORT 1957-58.

Sprayers and Dusters

Further experience was gained in testing machines in this group. Aspects which were studied, but on which further technique problems remain, include rapid sampling - using leaf disc cutters - for chemical estimation of spray and dust deposits, the use of leaf printing and fluorescent tracers for qualitative assessment of coverage, and collecting media and methods for the estimation of spray droplet spectra.

Band spraying

Preliminary investigations were made into the possibility of using a low-volume tractor-mounted sprayer for the band application of systemic insecticides to sugar beet. A 12-row boom was constructed and, after calibration, used to apply the insecticide in 7, 9 and 11 in. wide bands over the rows of plants with a consequent reduction in the amount of material used, as compared with normal spraying.

Spray Drift investigations

The occurrence of spray drift has been studied in order to suggest ways of preventing the damage now occasionally caused by a weedkiller drifting onto susceptible downwind crops. The results are best given in a form which describes the reduction in the proportion of the spray which drifts under average operating conditions; these are taken to be: nozzle height 18 in., spray output 5 gal/acre, working pressure 30 lb/sq.in., wind speed 5 m.p.h. relative to the nozzle.

It was found that changing the nozzle height from 18 to 12 in. reduces the initial drift to 50% of its usual value. The spray sheet angle must then be increased or the nozzle tilted forwards at an angle of 45° to maintain the swathe width of each nozzle. Decreasing the spray pressure from 35 to 15 lb/sq. in. and simultaneously increasing the nozzle size to increase the rate of application from 5 to 10 gal/acre decreases the drift by 75%. Flat spray nozzles give rise to less drift (40% in the particular examples) than hollow-cone ones. A deflector placed behind the nozzle, to drive the drift down towards the crop reduces the drift by 50% on the average.

The amount of drift increases in proportion to the resultant wind speed, compounded of tractor speed and ground wind speeds, so that there is twice as much drift at 10 m.p.h. as there is at 5 m.p.h.

From this tangle of factors it may be said with confidence that it is possible to reduce the spray drift on field crops from ground machines to less than 10% of its present level. Under 0.1% of the spray would then leave the treated field if it is bigger than one acre.

The measurements suggest that serious contamination of downwind crops is likely only where meteorological and topographical conditions are particularly favourable to dense deposition of the drift in localized areas. Accordingly, a reduction in the amount of drift leaving the spraying machines is not likely to reduce the incidence of cases of damage but will probably cause a fall in the extent and severity of the damage whenever it does occur.

Drift occurs only with drops with small terminal velocities. It is difficult to sample a spray accurately so that these small drops in it are recorded properly. A novel design of sampling chamber was made and tested. This was shown to give a reliable record of the fraction of spray formed into drops in the size range 20-100 microns.

Paper surfaces do not provide a consistent measure of the size of spray drops. A drop of given size spreads to form different-sized spray stains under varying circumstances. Casts made from plaster of Paris, were shown to be more constant in their behaviour over a wide range of conditions of measurement providing certain precautions are taken. It was, therefore, suggested that they might provide a convenient standard surface for measuring spray drop sizes.

A method was devised which overcomes many of the problems of measuring spray deposits. Visual judgment of visible spray deposits is used to make relative assessments of whether one deposit is heavier than another. This is an accurate and very quick process. Then a small number of instrumental measurements are made. This sets the relative assessments accurately within an absolute reference framework. It is felt that the principle of combining subjective assessment with instrumental calibration of that assessment, is a technique which might find widespread uses.

The work of the N.I.A.E. on locust control by contaminating natural pasture was summarized in a paper.

COTTON PEST RESEARCH SCHEME. QUARTERLY REPORT FOR JANUARY-MARCH, 1959

Gatooma Research Station

Diparopsis control

The Toxicity of Insecticides to Diparopsis Eggs: Eggs laid on muslin are being dipped in various concentrations of insecticide and the percentage of eggs hatching recorded. No insecticide tested has prevented the development of the egg, but as the 1st instar larvae eats its way out of the egg shell, larvae can be killed before they have left the egg shell. As this method is convenient for assessing toxicity, a full range of insecticides is being tested in this way.

The Toxicity of Insecticides to 1st Instar Larvae: The 1st instar larvae will invariably penetrate the nearest bud to the egg. The shortest distance the larva will wander over the plant is if the egg is laid on a bract. Preliminary experiments have been carried out by spraying the outside of the bracts with different concentrations of insecticide. The treated buds are then infested individually with one egg due to hatch within the following twenty-four hours. The efficiency of the insecticide is measured by the number of larvae which penetrate the buds. From results to date, the insecticide Sevin shows considerable promise.

NOTES ON THE TOXICITY TO FISH OF SOME COMMON AGRICULTURAL INSECTICIDES AND WEEDICIDES

Dr. G. A. PROWSE, Director, Fish Culture Research Institute,
Malacca (Malaya).

Insecticides

Derris elliptica - commonly used as a fish poison under the names rotenone and Tuba root (in Malaya). Attempts in Malacca to use decreased dosages to merely stun *Tilapia mossambica* were unsuccessful and all the fish subsequently died.

DDT. This was used to control midges (Nemittae) in the Nile at Khartoum, with numerous deaths of *Tilapia nilotica* and Nile perch. Tang & Chen (1) report that in *Chanos chanos* ponds in Taiwan the toxic effect of DDT is cumulative and not easily dispersed.

Endrin, dieldrin and aldrin. All are very toxic to fish, endrin more so than the others, 0.008 p.p.m. endrin being enough to kill fish according to Soong (2). In Malacca it is used as a piscicide at the rates of 0.06 p.p.m. Endrex = 0.012 p.p.m. endrin to clear ponds of all fish at the end of each experiment.

γ - benzene hexachloride. Lindane (99% γ -BHC) will kill *Chanos chanos* in 96 hours at a dosage of 0.1 p.p.m. according to Tang & Chen (1). The same authors quote that technical γ - BHC dust is toxic only at 1.25 p.p.m. whilst technical γ - BHC emulsion is toxic at 0.25 p.p.m.

Malathion. Tang & Cheng quote this to kill *Chanos chanos* in 96 hours at 0.5 p.p.m. as dust, and 0.25 p.p.m. as emulsion.

Weedicides

2-4-D has been used to control *Eichhornia crassipes* and other water weeds without adverse effect on fish, except imparting an unpleasant taste to the flesh.

(1) Tang, Y.A. & Chen, T.P. (1959).
Control of Chironomid larvae in Milkfish Ponds.
Chinese American Joint Commission on Rural Reconstruction
Fisheries Publication No. 4 Taiwan.

(2) Soong, M.K. & Merican, A.B.O. (1958).
The use of Endrin as a Piscicide in Mining Pools and Fish Ponds in Malaya. I.P.F.C. Technical publication 21.

2-4-5-T butyl ester has been tested in Malacca on Tilapia mossambica fingerlings. At 100 p.p.m. (274 lb/acre) half the fish died through oxygen lack due to the oil film on the water surface in the tank. At lower concentrations no adverse effects were seen. In the field, concentrations would be much lower, and it is doubtful if a continuous oil film would be formed.

Lallicide (sodium trichloracetate) commonly used in rubber estates, was tested against Tilapia fingerlings in Malacca. Even at 100 p.p.m. the fish showed no distress after several days contact. Since the spray is applied at about 100 lb/acre there appears to be no danger of fish poisoning.

Simazine (2-chloro-4, 6-bis (ethylamino)-s-triazine) was tested against Tilapia fingerlings at strengths up to 120 p.p.m. At the higher strengths 70% of the fish died within four hours, but after 12 hours the tanks were no longer toxic. It is probable that in drainage ditches, where this chemical would be used (at 60 p.p.m. or 40 lb. per acre) the toxic effect would be less and the fish would be able to escape. In any case the rapidity with which the toxicity of this chemical is dispersed makes it fairly safe to use.

In general the common weedicides seem to be fairly safe to use and will have no adverse effect on fish.

QUELEA CONTROL IN NIGERIA

Report on a Duty Visit to Bornu (Nigeria) to study methods used for the destruction of Quelea. J. M. Castel. CCTA/CSA, London, July 24, 1959.

The author gives particulars of the nesting and roosting sites. Nests are generally built on local varieties of thorn. Roosts are situated along marigots and near watering places and are highly concentrated in February. Nests are usually destroyed by hand, requiring a considerable labour force. Flame throwers as an alternative possess certain disadvantages. Roosts are destroyed by a combination of explosives and petrol.

Details are given of the equipment required, procedures and precautions to be taken. In effect, during the day when the birds are absent, drums of petrol/gas-oil are brought into the nesting area and placed over explosive charges (gelignite). The latter, joined by an instantaneous fuse or electric detonation system are caused to explode simultaneously at night when the birds are roosting. Some birds high up in the trees, not killed outright, inevitably die later through the burning of their wings.

Cost of the operations (tentative) is estimated at about 150,000 CFA francs* per hectare. In the course of a month's work the Bornu bird control unit destroyed about 20 million Quelea quelea quelea, which were eating 40 tons of grain daily, and which would, in September, have produced about 25 million young birds which in turn, would have caused damage amounting to 900,000 CFA francs* per day. "Contrary to appearances", states the author; "Quelea quelea quelea control is an undeniably paying proposition for the economy of the country and for the safeguarding of the population's food supply".

Monsieur Castel urges co-operation with neighbouring countries indicating that this should first take the form of an exhaustive study of the biology and habits of this species in the areas bordering on Lake Chad.

ROBUSTA COFFEE PRODUCTION IN THE EASTERN CARIBBEAN

T. S. JARVIS. Report on a Visit from September, 1956 to January, 1957. Development and Welfare in the West Indies. Bulletin No. 36.

This report is concerned with visits to Trinidad, British Guiana, and the Windward and Leeward Islands of Dominica, Grenada, St. Vincent, Antigua and Montserrat.

Trinidad and Tobago

The coffee-berry-borer-beetle, Stephanoderes hampei has not yet been found in the Caribbean. This pest is even now accounting for approximately 7% of the overhead costs of marketing the crop in Brazil and East Africa, and it can reduce the crop potential in any one year by 50%.

British Guiana

It is stated that the only disease seriously affecting the industry is that caused by Sclerotium coffeicolum.

Windward and Leeward Islands

Coffee is menaced by the leaf-miner, (Leucoptera coffeella) and this pest must be eradicated or adequately controlled before the crop can be cultivated successfully. No information exists as to host plants other than coffee; but there is no doubt whatsoever that it prefers Arabica coffee to anything else, and the bushes of this variety that are still to be seen in the island carry the pest in almost every leaf. Where the two types Arabica and Robusta are found growing together, the

(* ca 600 francs then equivalent to £1 sterling.)

pest having destroyed all the leaves of the former, will eventually move across to the latter and can do equal damage there. Fortunately, Robusta carries a lot of leaf and the danger to crop production is not as great as with Arabica, but there is danger nevertheless.

To control this pest it will be necessary first to clean up by the systematic and simultaneous burning of all affected leaf. In no other way can the larvae be got at. The absence of birds allows the moth to flit at will; and the pest is now in epidemic form in all the islands of the Lesser Antilles. The moth appears to be fairly local, and it would not be difficult to organise an effective campaign for its control if not its extermination.

It is suggested that all Arabica trees should be recorded, and each one of them sprayed with sodium arsenite, one or two oz. to the gallon of water, in order to burn all the leaves. At the same time each of the trees should be given a liberal feed of sulphate of ammonia in order to flush fresh leaf growth, and when the new leaves have in turn been mined, and most of the leaves are infected, the burning with sodium arsenite should be repeated. By so using the Arabica coffee to bait the moth and then to destroy the larvae in the leaf when a maximum concentration or infestation has been built up, it is hoped that the population will be systematically and steadily reduced until natural control can take over.

The author would caution the Government against the possible introduction by well-meaning but ill-advised coffee enthusiasts of the arch enemy to coffee, the coffee-berry-borer-beetle Stephanoderes hampei, which in Brazil and East Africa is causing the authorities grave concern, and the coffee industry heavy loss, because it not merely damages the bean and so adversely affects the physical quality of the product, but it causes a direct loss in crop which can amount to 50% of the crop potential in any one year. This beetle has not yet been identified in the Caribbean and the importation of any coffee material from outside of the Caribbean islands should therefore be prevented by legislation.

REPORT OF THE FIRST MEETING OF THE JOINT FAO/OIE EXPERT PANEL ON TICK-BORNE DISEASES OF LIVESTOCK, LONDON, NOVEMBER 1958.

Food and Agriculture Organization of the United Nations.

The Control of Ticks

On Land

Burning, as practised over most regions of Africa, was considered of doubtful value from the point of view of destruction of tick populations. The indirect effect of altering the vegetative nature of the environment and thus modifying the micro-climate upon which many species of ticks are dependent may profoundly influence the population density of certain tick species.

Systems of livestock management: The principles governing tick control under this heading are aimed at starvation of the tick in all or in one or other of its development stages by separating it from its hosts or by altering its micro-climatic requirements by the introduction of the animal factors, e.g. over-grazing of pastures. Examples of success having been achieved in the control of East Coast fever by combinations of quarantine and dipping or slaughter-out in Africa have been recorded, but due to the presence of alternative hosts, the transmitting tick itself has not been eliminated and success can be ascribed to the non-persistence of the infection in the invertebrate host. Pasture spelling in Australia has brought about satisfactory control in the case of Boophilus microplus. In certain restricted areas, rotational grazing combined with mechanical treatment of the soil to expose the ticks present in their non-parasitic phases to the desiccating effects of sunlight and air or to low temperatures have been productive of fairly successful control as reported from Russia. Flooding of tick infected regions was considered but, due to the resistance of ticks to total immersion, this method was not considered effective apart from having only a limited application.

The application of fertilisers to pasture by various means and the possible incorporation of ixodicides for tick control was considered in the light of several literature references to small scale experiments having been conducted in different countries, but the work was considered to be insufficiently advanced at this stage to justify conclusions being drawn.

The use of absorptive or abrasive dusts (applied as yet mainly to stored-products insects) has been recorded, where satisfactory control by physical means through removal of or damage to the epicuticular wax covering was considered, as well as its possible application to the control of ticks. Here it was pointed out that by virtue of the effects exerted being physical in nature, the method merited investigation in view of the development of resistance to ixodicides noted in certain areas, which this method obviated.

On animals

Methods of application of ixodicides: It was considered that with the present ixodicides the most satisfactory means of application was by the use of either the spray race or dip. It was felt, however, that other methods such as dusting, fogging and parenteral or systemic should receive attention as new materials or formulations became available for testing.

Because of the inability thoroughly to wet all parts of the animal's body through mechanical difficulties in the construction of a spray race, it was felt that in any eradication campaign the use of dipping vats was the most satisfactory method of application of medicaments. It was pointed out, however, that dipping vats may not be 100 per cent. effective as evidenced by the failure of the tick eradication scheme in New South Wales, Australia. This, however, may not be due to an inherent fault of the dip but to the limitations of the medicament and the type of formulation employed.

The advantages and disadvantages of spray races and dips were considered and it was generally felt that the spray race was very satisfactory where control and not eradication was the aim. The spray race has been modified from time to time especially in length, type and location of nozzles until, at the present time, the so-called water-well, i.e. high volume, low pressure types of spray race, appears to be the most satisfactory type for control of ticks on cattle. However, because of the rapid stripping action of wool on ixodicides a spray race in which the medicament draining from the sheep is discarded, was considered to be highly desirable.

Ixodicides: Arsenic still seems to be the most satisfactory ixodicide used in the control of three-host ticks such as Rhipicephalus appendiculatus in South Africa, whereas many of the newer ixodicides are more efficient in controlling one-host ticks such as Boophilus decoloratus and B.microplus. Arsenic, however, is still used extensively to control B.annulatus and B.microplus in America, B.microplus in Australia and B.decoloratus in Africa. In South Africa, BHC or DDT is incorporated in the arsenical dips where resistance to arsenic occurs. Where resistance to both arsenic and BHC occurs in South Africa, organic phosphorus preparations are being recommended.

Many of the newer ixodicides have been tested in Australia with good results but because ticks in various areas have developed resistance to one or more of these ixodicides attention has been turned towards the organic phosphorus compounds. 'Asuntol', 'Delnav' and diazinon have been prepared in stable formulations for use in dipping vats and excellent results have been recorded. In Australia, the combination of DDT and diazinon in a dip has shown good results even when used at half the concentration recommended for each medicament when used separately. The synergistic effect of these and other combinations is being investigated.

The use of other medicaments, e.g. synergised pyrethrin and rotenone, although not normally economic, may be warranted in special circumstances.

It was considered that further efforts might be made to find the ideal ixodicide which may be defined as having the following properties:

(1) efficient - immediate kill of all stages
(2) persistent - residual action against all stages
(3) usable in dips - water soluble and stable
(4) easy, rapid vat side test for concentration
(5) will not lead to rapid development of resistance
(6) safe and no residues in animal tissues
(7) economical
(8) freedom from human hazard.

Many of the present ixodicides have one or more of these characteristics but none fulfil all or the majority of these requirements.

Resistance to Ixodicides: Resistance to ixodicides has been recorded only in the one-host tick, *Boophilus* - *B.microplus*, *B.decoloratus* and *B.annulatus*. Resistance has been observed in the majority of countries where this genus occurs and where various ixodicides are being used to control infestations. Resistance to arsenic, BHC, DDT, toxaphene and dieldrin was recorded but not yet to the organic phosphorus compounds. The phenomenon of resistance is extremely puzzling because of the irregular and widespread distribution of the condition. Adjoining properties may have ticks which are resistant or susceptible to a particular ixodicide. Resistance may develop very rapidly, after one or two treatments in some instances (more particularly with certain ixodicides), whereas the same ixodicide has been used for years on other properties without any evidence of resistance.

Methods of Controlling resistant ticks: It was considered advisable to recommend initially the use of ixodicides at the highest safe and economic concentration. If resistance did develop, change should be made to a completely different class of compounds which fortunately are available.

Control of Ticks by Biological Means: Parasitic invasion by the wasps *Hunterellus hookeri* and *H.theilerae* of *Hyalomma* or possibly other ticks in the moulting stage may be responsible for heavy mortality of the species with up to 80 per cent. being affected. The parasites may be carried great distances for example from Central Africa to Europe in nymphal stages which may be attached to migrating birds.

Predators including ants, spiders, mites and birds also play an important part in controlling tick populations.

Available information on the effects of parasites and predators is rather meagre but it would appear that such means of biological control could be very important; further investigation of this subject would be justified.

Repellents: The possible application of repellents to deter infestation with ticks was considered. The use of such compounds has as yet been largely confined to application to the skin or clothing of human beings, although an instance of their use to repel *Stomoxys* from dogs was quoted

The persistence of repellents on the skin has so far been of too short duration to be of practical value but the Panel recognised the possible use of repellents either applied to the skin or administered internally, as a possible method in the control of ticks on animals.

THE TOXICITY OF SOME ORGANO-PHOSPHORUS COMPOUNDS TO MOSQUITOES AND HOUSEFLIES

A. B. HADAWAY and F. BARLOW. Colonial Pesticides Research Unit, Porton. Report No. 164.

This report is concerned with the determination, by topical application, of the toxicity of a number of new insecticides to *Aedes aegypti*, *Anopheles stephensi* and to *Musca domestica*. Insects used in these tests were normal strains with no previous history of contact with insecticides, and were reared by standard methods at 25-27°C.

Pure samples of 12 insecticides were tested. A measured volume of insecticide solution was applied to the dorsal surface of the thorax of individual insects from a microburette. Volumes of solutions applied varied from 0.01 to 0.03 μ l. for mosquitoes, and from 0.022 to 0.058 μ l. for houseflies. The concentration of insecticide required to give a range of kills with these volumes was determined in preliminary experiments. Four or five dosages of each insecticide were applied to batches of 30 insects which were then stored at 25°C for 24 hours before mortality counts were made. Percentage kills were converted to probits and plotted against the logarithm of the dosage, and median lethal doses (LD_{50}) were read from provisional regression lines.

In previous work with chlorinated hydrocarbons topical applications were made with kerosene solutions. Many of the organo-phosphorus insecticides, however, have a low solubility in petroleum oils, and it became necessary to find a suitable medium which has good solvent properties for a variety of compounds, which is non-toxic to the test insects, and whose physical properties (viscosity and volatility) allows its use in the microburette. Acetone is too volatile. The most suitable cheap solvent found was di-isobutyl ketone (DBK), b.pt. 168°C, viscosity 0.84 cps. at 25°C, of which a technical grade (B.D.H. Ltd.) was satisfactory. This spread readily on the insect cuticle and had no adverse effects on the insects when volumes greater than those normally used in tests were applied.

Results

Median lethal doses, in/μg. x 10^3 per insect, of 12 organo-phosphoru insecticides applied topically in solution in di-iso-butyl ketone were as follows:

	A.aegypti	A.stephensi	M.domestica
Chlorthion	3	7	330
Diazinon	16	6	43
Malathion	5	5	710
Parathion	1	1	20
Isochlorthion	4	4	60
Rogor	5	3	13
Resitox	12	2	60
Gusathion	8	3	110
Trolene	21	16	69
Morphothion	22	9	520
Dipterex	25	17	460
Trithion	162	37	320

The relative toxicity of any two compounds varied considerably from one species to another. In general, the compounds tested were more toxic to A.stephensi than to A.aegypti, but Chlorthion was an exception to this general rule. Chlorthion and malathion were highly toxic to both species of mosquito but showed a relatively low toxicity to houseflies. Trolene, on the other hand, was poor against mosquitoes but relatively toxic to houseflies. Rogor, which was developed as a systemic insecticide, was highly toxic to mosquitoes and houseflies, and was more toxic than parathion to houseflies. Isochlorthion was much more toxic than Chlorthion to houseflies.

DROP SPECTRA FROM ROTARY BRUSHES FITTED TO THE D. H. BEAVER AIRCRAFT

D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika.
Miscellaneous Report No. 235.

A limited number of trials have been carried out to determine the physical performance of rotary brushes fitted to a D.H. Beaver aircraft. The equipment was the standard form supplied with the aircraft, in which the liquid is gravity-fed into brushes suspended in line with the end of the wing struts, roughly on a level with the bottom of the fuselage.

There was insufficient time to carry out detailed emission tests. The drop spectra were determined for emissions obtained with small quantities only (about 15 gallons) in the storage tank, and the emission rates are only approximately correct. The liquid was the proprietary solvent Dutrex 3/Novasol, in which approximately 0.75 per cent. (w/v) Waxoline Red, an oil-soluble dye, was dissolved.

Methods: Ground deposits were collected upon filter papers and oxide-coated plates. The former samples were extracted and deposits were determined colorimetrically; microscopical counts on the oxide-coated plates were used to calculate droplet distributions.

Results are recorded in graphical and tabular form.

Discussion: Evidently the brushes with diameters of 10 inches gave the finest droplets while increases in emission rate coarsened the spectra. The oxide coated plates slightly over-estimated droplet sizes of the coarser spectra.

Contamination of the tailplane occurred in all tests.

AIRCRAFT APPLICATIONS OF INSECTICIDES IN EAST AFRICA. (XIII) AN ATTEMPT TO REDUCE THE COST OF CONTROLLING THE TSETSE SPECIES GLOSSINA MORSITANS WEST., G.SWYNNERTONI AUST. AND G.PALLIDIPES AUST. IN SAVANNAH WOODLAND.

R. FOSTER, P. J. WHITE AND D. YEO. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 236.

Authors' Summary

Following successful small-scale trials, an attempt was made to eradicate tsetse flies from an isolated block of woodland at Chungai, in the Central Province of Tanganyika. An Auster aircraft, fitted with Britten-Norman rotary cage spraying units, was used to apply a five per cent (w/v) solution of gamma BHC at a nominal dosage of 0.08 gallons

per acre. This was equivalent to 0.04 pounds of gamma BHC per acre. The treated area was approximately 11 square miles in extent, and contained G.morsitans and G.pallidipes.

Seven applications were made, at approximately 28 day intervals.

Although the preliminary small-scale trials of the method had given high mortalities of G.swynnertoni and G.morsitans, the large-scale operation at Chungai failed to control either of the species there. The first two applications reduced the apparent density of G.morsitans by about 90 per cent. and that of G.pallidipes to a somewhat lesser extent. The later applications however gave varying and often low mortalities, and the populations increased slowly for some time, the insecticide applications causing only temporary depressions in numbers. Numbers fell towards the end of the operation, but the final reductions were only about 50 per cent. or less. Kills of female flies were low throughout the operation, and this factor undoubtedly led to the eventual failure.

The low mortalities are discussed; the low volume dosage, the drop spectrum, adverse meteorological conditions and biological factors are suggested as possible causes.

Operational costs in the experiment were considerably lower than in previous work. Improvements in technique may lead to satisfactory control at a cost which, although higher than incurred here, may still be economic.

AN APPARATUS FOR THE PROLONGED AND ACCURATE DISPENSING OF SUSPENSIONS AND SOLUTIONS

R. FOSTER and G. F. POULTON. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 241. Aug. 1959.

The apparatus which, is, in principle, a constant pressure head device, consists of a polythene bottle (about 2 litres capacity) equipped with mechanical agitator, overflow tube, and feed pipe, through which the flow of molluscicide from reservoir to bottle (always kept full) is controlled by a Hoffmann type clamp.

A brass delivery tube, inserted at an angle through a hole drilled in the base of the bottle, incorporates a selector possessing a number of different sized orifices. (An orifice of 0.136" diameter was shown to give a flow rate of approx. 15 ml/sec.)

Treatment of a wide range of flowing waters is possible by using a suitable concentration of the molluscicide in conjunction with a particular orifice. The apparatus is best adapted to the treatment of waters of constant flow.

For further details of construction and an account of its performance in short and long term trials using test suspensions of Bayer 73 (2 hydroxy-5,2-dichloro-4-nitrobenzanilide), the original report should be consulted.

THE PICK-UP OF INSECTICIDE BY SETTLED LOCUSTS

D. YEO and H. J. SAYER. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 237. July 1959.

The authors comment as follows:

"A peculiar feature of control of the Desert Locust (Schistocerca gregaria Forsk.), by aircraft applications of insecticides against adult swarms, is that the swathes are largely independent of one another, in contrast to the more usual case where successive swathes can be positioned sufficiently accurately for a relatively uniform dosage to be applied to the target area. Against settled swarms, therefore, the distribution of dosage will vary with wind speed, aircraft height, and droplet sizes, and there will be consequent changes in the kill of locusts.

Interest is thus centred upon the dosage distributions obtained from single passages of the aircraft. In conditions of no wind a locust would be expected to receive dosages equal to that falling on a horizontal surface with a plan area equal to that of the locust. In a wind, however, the collection of droplets by a locust will be greater than that of a horizontal surface with the same area, because the locust presents a larger area at right angles to the direction of movement of the droplets. This area, presented at right angles to the droplets, is called the normal equivalent area (McCuaig, 1958), and has been shown to be about 5 cm^2 for settled locusts. Evidently the greater the wind speed, and the smaller the droplet, both of which lead to more horizontal trajectories, the greater will be the dosage received by the locust compared with the deposit upon a flat horizontal surface.

In theory, it is possible to calculate the dosages received by locusts under various conditions, using principles described by Gunn et al (1948). This has been done by Yeo (1959). For coarse sprays, and height-wind products (see Gunn et al, 1948) of a few hundreds (ft. x m.p.h.) it is likely that the calculations give a fair approximation to what happens in practice. With low aircraft heights and small droplets, however, the turbulence induced by the aircraft, and the ambient atmospheric turbulence, are likely to modify dosage distributions furthermore, for locusts settled on the ground surface it is difficult to assign a value to the trajectories of the droplets because of the rapidity with which the wind speed varies over the centimetre or so just above the ground, so that some experimental work is desirable.

Some tests were therefore carried out to determine the dosage distributions achieved under field conditions. Unfortunately there were variations in droplet sizes, for other experimental reasons, and the results are neither very accurate nor comprehensive; they may nevertheless be of value for planning control operations of the immediate future".

Experimental details

The spray consisted of D.N.O.C. (22% w/v) in oil applied from (1) a D.H. Beaver aircraft fitted with a boom-and-nozzle system extending the full wing span. (2) an Auster J5G fitted with a Britten-Norman rotary cage atomiser at each wing tip.

Aircraft were flow approximately at 90° to the wind and at a height of about 30 ft. Ground deposits were sampled at distances downwind by glass plates placed on large boards. Distribution of droplet sizes was calculated from microscopical size counts of the craters produced by the droplets in magnesium oxide. Locusts were simulated by glass cylinders (5 cm. x 1 cm. diam.) placed at various heights orientated along the line of flight.

References

Gunn, D. L. et al.	(1948).	Anti-Locust Bulletin No. 4.
McCuaig, R. D.	(1958).	Nature, 182, 478.
Yeo, D.	(1959).	Annual Report, Colonial Pesticides Research Unit, Arusha, Tanganyika.

ANALYSIS OF DATA IN THE COCONUT PEST RESEARCH. PROGRESS REPORT FOR THE PERIOD ENDING MARCH 31st, 1959

K. S. McKINLAY. Colonial Pesticides Research Unit, Arusha, Tanganyika. Miscellaneous Report No. 239. July 1959.

This report is concerned with a preliminary analysis of Vanderplank' report which was abstracted in PANS 'A', 5 (3), p.399. "As Vanderplank mentions in his report it is obvious that both yield and the percentage of palms with Oecophylla are related to stand. However, his further thesis depends upon relating yield and any increase due to spraying to stand only, ignoring a possibly inter-acting effect due to Oecophylla. It is obvious from previous field observation that Oecophylla, by deterring Pseudotheraptus, must also have an effect upon yield and therefore one must carry out a partial regression analysis, to take into account the effects of both factors".

Using data from Vanderplank's results an equation is calculated and then used to calculate possible yields from varying stands and degrees of Oecophylla infestations.

"The main indications are:-

(a) For any given stand any increase in Oecophylla leads to increased yields, as would be expected.

(b) As palm density is increased then yield per palm decreases.

(c) However, for anything less than 100% of the palms having Oecophylla there is a certain optimum stand to give the maximum yield per acre. For example if 20% of the palms have Oecophylla then the optimum palm density would be about 40 palms per acre. If 60% of the palms are to be infested with Oecophylla then the optimum stand for maximum yield per acre would be 70 palms per acre.

(d) One would expect yield per palm to drop as palm density increased but from this equation it appears to drop too much. For example with no Oecophylla present the expected yield from 90 palms per acre is nil. The only explanation that one can put forward for this is that just as Oecophylla tends to be favoured by dense stands so is Pseudotheraptus. Thus when no Oecophylla are present a palm density of 90 palms per acre would be so favourable that Pseudotheraptus would build up sufficiently to take the entire crop."

Since in the experimental block high Oecophylla infestations are only found in dense stands and low Oecophylla populations in low stands, palm density and Oecophylla are related and a further regression equation is calculated.

Combining the two equations, the expected number of palms infested with Oecophylla; the expected number of nuts per palm, and the expected yield per acre, are calculated for given densities of palms ranging from 20 to 90 per acre.

From the yields resulting from the first year of spraying, 1957-58 a multiple regression equation is calculated and used to predict the increases in yield that could be expected under different conditions viz.

PROPORTIONAL INCREASE IN YIELD THAT COULD BE EXPECTED FROM PSEUDOTHERAPTUS CONTROL

% Oecophylla Palms	Stand				
	20	40	50	60	80
0	2.52	2.58	2.61	2.64	2.70
20	2.04	2.10	2.13	2.16	2.22
40	1.55	1.61	1.64	1.67	1.73
60	1.07	1.13	1.16	1.19	1.25
80	0.58	0.64	0.67	0.70	0.76

"With the usual reservations this implies:-

1. For any given amount of Oecophylla the denser the stand, the greater is the return from spraying. This apparently contradicts Vanderplank who suggests in his report that it would not pay to spray dense stands but that the solution to the Pseudotheraptus problem was to plant 90 palms per acre. However, this is only an apparent contradiction, as will be seen below.

2. For any given stand, the greater the percentage of palms having Oecophylla the less return from spraying. This might be expected for if 60% of palms are already protected by Oecophylla you could not expect the same increase from spraying as in an area where there less palms with Oecophylla.

3. It will be seen in the table that calculation from this last equation suggests that where more than 80% of palms have Oecophylla then spraying might lead to a decrease in yield.

There are two suggestions to make here:-

(a) An 80% Oecophylla infestation gives a more efficient protection than spraying and insecticides only upset the balance adversely. (We have no data on this which could be used to judge the thesis. However, confirmation, or otherwise, could be obtained from further field work).

Or (b). We are not justified in extrapolating the data beyond our actual figures. As explained before Oecophylla populations and stand are related, therefore, using the last two named equations we can show what situations are likely to occur as in the table.

OECOPHYLLA POPULATIONS AND YIELD INCREASES TO BE EXPECTED AFTER SPRAYING AT KIDICHI

Palms/Acre	20	30	40	50	60	70	80	90
% Palms with Oecophylla expected	47	51	54	58	62	65	69	73
Proportional increase in yield expected	1.39	1.33	1.27	1.20	1.14	1.08	1.02	0.96

As will be seen from the table, in the overall effect Vanderplank was quite correct; the denser the stand, the less the return in practice, from spraying. However, the additional analysis in this report shows that it is not due to stand, but rather due to the Oecophylla population which is itself related to stand. That is, denser stands have more Oecophylla and because of this the increase from spraying is less.

Checking the equations against the results from the entire sprayed area we get:-

Total Nuts from Experimental Block, 1956/7 205,873
" " " " 1957/8 236,424

Increase due to spray 1.15.

Total palms, Experimental Block 4404
Total acres, " " 78

Palms/acre ... 56.4

Total palms, Experimental Block, with Oecophylla 2714

61% Oecophylla

Calculated increase to be expected from whole experiment is 1.13 which agrees very well with what actually happened.

The control block shows a similar relationship between Oecophylla infestation, stand and yield. It is interesting to calculate the increase in yield which might have been expected if the Control block had been sprayed.

Control Block

Total palms 3459 on 93 acres = 37.2 palms/acre
" " with Oecophylla = 1144 = 33%

Substituting these values, one might have expected spraying to increase the yield 1.77 times or 77% compared with the 1.15 or 15% increase obtained on the present sprayed block where there are, overall, 56.4 palms per acre of which 61.7% contain Oecophylla.

Discussion

"The most striking point arising out of the analysis is the way in which the mechanisms displayed may account for the confusing, and often conflicting yield results which have been obtained in previous Pseudotheraptus control experiments. For example the purely fortuitous choice of the present control block as the one to be sprayed might have led to a satisfying 77. increase in yield instead of the disappointing 15% actually obtained on the present sprayed block. Even more vitally, the analysis suggests that one needs a great deal of data before embarking upon a large scale control scheme with insecticides. If, for example, infestations of over 60% of the palms with Oecophylla were common in Zanzibar the analysis suggests that spraying would not be an economical proposition."

Suggestions are given for further field work from which it might be possible "to draw more adequate conclusions as to the role of all factors involved and make a more realistic judgment of the possibilities of insecticidal control schemes.

If areas of high and low palm densities with varying populations of Oecophylla and Pseudotheraptus could be found then very valuable direct insecticide experiments could be carried out.

One cannot help feeling that so many factors are involved, and so little is known about them for certain, that it would be extremely rash to get involved in any large scale control schemes at present".

A SURVEY OF THE USE OF MAIZE STALK BORER CONTROL METHODS IN EAST AFRICA.

P. T. WALKER. Colonial Pesticides Research Unit, Porton.
Report No. 163. June 1959.

According to the author this survey, carried out in 1957 is based on a number of estimates and opinions provided by agricultural and commercial staff and farmers. Three categories of maize growing are recognised, viz:

(a) non-European, mostly African, primitive peasant holdings, usually from two to nine acres of cereals, often scattered and irregular in shape, often intercropped with peasant type crops.

(b) non-European, mostly African, small-holdings of the same size but progressive, and tending to include more cash crops such as coffee, cotton or vegetables.

(c) mostly European, but with increasing numbers of African, estate farms, using mechanical equipment and employing labour. Great range of size, but many 500-2,000 acres.

Some DDT 2½% dust is being used by (a) in the Tabora district but not extensively elsewhere, application being made with an improvised tin or scoop. DDT dust and other insecticides are being more widely applied by (b) frequently using hand dusters and pressure sprayers. It is in category (c) that the greatest mechanisation has taken place.

Among roughly 400 farms per district each with at least two tractors and probably at least 100-200 acres of maize the proportion applying insecticide has been estimated at 60-80%.

Various insecticides are used, particularly DDT 2% or 2½% dust, (much of which is formulated locally), and DDT emulsion. It is likely that some 16% of maize growers applying insecticide for borer do so by tractor drawn sprayer.

The survey presents further evidence in support of these findings and also refers to local differences in the practice of control measures.

INTERNATIONAL AGRICULTURAL AVIATION CONFERENCE

Papers presented to the Conference held in September at the College of Aeronautics, Cranfield, covered, in 11 Sessions, many aspects of agricultural aviation, ranging from engineering (aircraft equipment and design) to biology (application effects on pests and wild life), physics (spray drift) and airmanship.

Delegates, many of whom were visitors to the United Kingdom, benifitted from a lively exchange of views, providing aims for future research. The demonstration on the 4th day proved most popular.

The following notes are based on selected progress reports relevant to the control of pests.

Biological effectiveness

Hunnam and Dash (1) on the control of apple orchard pests and diseases, thought that aerial application could only be fully successful through the use of systemics. Rose (2) hinted on the need for a different droplet spectra. Engel (3) reported satisfactory cherry fruit fly control using a helicopter and a highly concentrated DDT emulsion, though at the cost of 60% waste of material through drift etc. Courshee (4) gave an account of experiments designed to simulate small volume aerial spraying against potato late blight, with the object of establishing practical considerations.

Spray drift

Hartley (5), to shorten the route to obtaining experimental data, proposed trial sprayings on the upwind side of large white mustard fields, destined in any case for ploughing in as green manure, with a hormone spray "marker". He underlined in relation to drift the bearing of the initial size of a droplet on its evaporation rate. Thus water droplets of 200, 100 and 50 microns diameter would have life-times of 63, 16 and 4 seconds respectively (at 15°C. and 40% R.H.); the corresponding rates of fall in still air would be approx. 2, 1 and 0.5 ft. per second. Courshee (6) indicated that it was possible to reduce spray drift by flying low, avoiding the formation of small droplets and moving the nozzles inboard and low down. He also advocated the use of flat fan nozzles pointed rearwards at about 30°.

Little (7), (8) describing the aerial application of hormone weedkillers in New Zealand indicated that the drift hazarded had now been largely minimised by applying coarse low volume spray with water as the diluent from a low flying aircraft, e.g. a helicopter flown at 25-30 m.p.h. operating under moderate wind conditions (10-15 m.p.h.).

Aircraft and Equipment

Authors drew attention to the suitability of the helicopter for crop spraying and to the need for reducing cost, maintenance, and for improving design and handling ability. Improvements of the required form for helicopter design were put forward by van de Ree (9). Britten (10) discussed the suitability of a modified rotary atomiser for the dissemination of the concentrated spray materials normally employed in aerial work which may frequently clog or abrade conventional jet nozzles. An interesting development is a direct drive permitting the use of four atomisers for row crop spraying, thereby eliminating the disadvantage of twin-peak deposit upon minimum height spray runs.

A method of using silicone polished glass slides for determining droplet distribution, size and swathe width was described by French (11). The slides, supported on surveyor's chains at specified intervals across the flight path, are sprayed with water containing 3% Nigrosine. Afterwards the slides are collected together to be studied at leisure.

Side Effects

The widespread effects on wild life of pesticides applied from the air were reviewed by Potter (12). He suggested observance of the following precautions: to use a selective chemical, to avoid overdosing, to operate only when conditions are suitable and by a combination of skill, technique and well designed equipment to apply material most efficiently. Additional precautions to safeguard fisheries from aerial spraying, were proposed by Alabaster and Abram (13). These included, care in the disposal of surplus material, empty containers and other contaminated articles, and for preference, the use of substances of low toxicity to fish.

Proceedings of the Conference will be available in due course, from the Organisers. Copies of some of the papers are likely to be available in advance on application to the authors.

References

1.	D. Hunnam and C. R. Dash.	"Investigation into the control of pests and diseases on apples by aerial spraying during the season 1959.
2.	G. J. Rose.	"A preliminary note upon orchard spraying trials with aircraft in the U.K."
3.	Dr. Engel, Germany.	"Cherry fruit fly control using helicopters".
4.	R. J. Courshee.	"Experiments on applying copper for control of potato late blight".
5.	Dr. G. Hartley.	"The physics of spray drift".
6.	R. J. Courshee.	"Drift of spray from low-flying aeroplanes".
7. &	E. C. S. Little, New Zealand.	"Spraying weeds from the air".
8.	" " " "	"The development of helicopters in New Zealand".
9.	W. G. van de Ree, Holland.	"Requirements for an agricultural helicopter".
10.	F. R. J. Britten.	"Some developments in rotary atomisers".

11.	C. B. French.	"Practical determination by a comparative method of droplet distribution size and swath width".
12.	Dr. C. Potter.	"The risk to wild life from aerial spraying".
13.	J. S. Alabaster and F. S. H. Abram.	"The danger to fisheries from aerial spraying".

Other Progress Reports not reviewed above

1.	H. Shields, U.S.A.	"Forest fire suppression".
2.	I. A. Nicholson.	"Hill pastures improvement problems and the significance of aircraft".
3.	R. H. Beatty, U.S.A.	"Invert emulsions".
4.	F. R. J. Britten and G. J. Rose.	"Some effects of droplet size upon recovery of sprays".
5.	R. Powell.	"Distribution of different physical forms of nitrogenous fertiliser when applied from the air".
6.	F. E. Weick, U.S.A.	"The design philosophy of the Piper "Pawnee" agricultural aeroplane".
7.	G. Sanders, U.S.A.	"New aircraft and equipment".
8.	F. R. J. Britten.	"The distribution of granular fertilisers from light aircraft".
9.	F. Watkin.	"Some aircraft installation problems".
10.	S. W. G. Foster.	"Corrosion of metals".
11.	S. W. G. Foster.	"Economic factors affecting the agricultural aeroplane manufacturer".
12.	D. B. Carter.	"Agricultural aviation considered from the point of view of agricultural requirements with particular reference to world problems".
13.	C. G. S. Saunders.	"The economics of fertiliser application from the air".
14.	P. King.	"The potential for aerial treatments in the U.K.".
15.	D. Nahum.	"Some factors affecting the economics of agricultural aviation in the U.K.".
16.	J. Brown.	"The profitability of agricultural aviation".
17.	G. Sanders, U.S.A.	"Agricultural aviation operations".
18.	J. R. McMahon.	"Safety related to the particular weather and topographical conditions of the U.K.".
19.	S. W. G. Foster.	"The causes of accidents in agricultural aviation".

20.	B. M. Austin Bourke.	"Meteorological aspects of agricultural aviation".
21.	Wing Commander P. R. Hatfield.	"Practical aspects of agricultural flying".
22.	Dr. G. Haronska, Germany.	"Beaconing".
23.	D. Nahum.	"Fertiliser application-ground organisation".

Main Papers

1.	Lord Netherthorpe, B.Sc., Ll.D (Hon.).	Official opening of Conference and address of welcome to delegates
2.	Sir Miles Thomas, D.F.C., M.I. Mech.E., M.S.A.E.	"Inaugural paper: A review of developments in agricultural aviation".
3.	Mr. R. C. Amsden (Chesterford Park Research Station).	"The biological basis of aerial agriculture".
4.	Dr. J. K. Eaton, (Woodstock Agricultural Research Station).	"Review of materials for aerial application".
5.	Mr. D. Yeo, B.Sc. (Colonial Pesticides Research Unit).	"The problem of distribution: the physics of falling droplets and particles. The drift hazard". (Read by Dr. A. B. Hadaway.)
6.	Mr. J. E. Harper, B.A. (Agric.) (Fisons Airwork Ltd.)	"Aircraft: the operator's requirements".
7.	Mr. R. F. Hill, A.F.R.Ae.S. (Colonial Pesticides Research Unit).	"Distribution equipment".
8.	Mr. H. G. Winton, A.F.R.Ae.S. (Air Registration Board).	"International airworthiness requirements for agricultural aircraft".
9.	Mr. F. C. Potter, M.A., A.I.M. (Aluminium Development Association)	"Corrosion by agricultural chemicals in airframes and equipment".
10.	Mr. N. D. Norman (Crop Culture (Aerial) Ltd.)	"Economic factors affecting agricultural aircraft operations".
11.	Dr. E. F. Edson, M.Sc., M.B., Ch.B. (Hons.) (ChesterfordPark Research Station).	"Toxicological aspects: safety precautions".
12.	Mr. L. R. Lucassen (National Aeronautical Research Institute, Amsterdam).	"Techniques of low flying and flight safety". (Read by Dr. W. J. Maan).
13.	Capt. R. Bradbury (Fisons Airwork Ltd.)	"Ground organisation - (i) The pilot's view".
14.	Mr. Michael Bradford (National Association of Corn and Agricultural Merchants).	"Ground organisation - (ii) The ground operator's view".

USES OF RADIOACTIVE MATERIALS IN ENTOMOLOGY: A REVIEW

C. R. MacLELLAN. Crop Insect Section, Science Service Laboratory, Kentville, N.S.

Proceedings of the Fifth Annual Meeting Agricultural Pesticide Technical Society,* June 23-26, 1958, pp.6-19.

It is generally believed, by research workers and laymen alike, that the use of radioactive materials in research began with the discovery of uranium fission and its military significance. Although great impetus has been given to atomic energy research since that famous discovery, previously several workers explored the use of radioactive materials in entomological research. Runner (1916) used x-rays on the cigarette beetle, and learned that lighter exposures were required to sterilize newly laid eggs than those required to sterilize eggs near the hatching stage. All larvae that he treated failed to reach the pupal stage. In the same decade Davey (1919) reported that small doses of x-rays apparently increased the life of the confused flour beetle. It was not until 1931 that Campbell and Lukens (1931) initiated radioactive techniques. They used radioactive acid lead arsenate to study its solubility within the alimentary tract of the silkworm.

Hamilton (1935) fed the green peach aphid polonium-212, an alpha particle emitter, and found that the polonium was transmitted to a leaf by the feeding aphids. He suggested that viruses could be transmitted in a similar manner. In physiological work, Lindsay and Craig (1942) followed the distribution of radiophosphorus in four species of insects and found that phosphorus-32 (P^{32}) was concentrated least in the fat body and most in the mid-intestine, reproductive ducts, and gonads. In 1946 Tomes and Brian marked the first insects for movement studies. Radium sulphate was fastened beneath the elytra of female click beetles to study the movements of the beetles on the surface of the soil. Since then many radioactive materials have become readily available to research workers.

The great potentialities of radioisotopes as research tools are not appreciated to the extent they deserve. Many problems that could best be solved by the use of radioisotopes may be left unsolved because of a fear of handling radioactive materials. With the necessary basic precautions, however, radioisotopes can be handled easily and safely without endangering personal health. Studies on flight movements, dispersal, and behaviour of many of our worst insect pests have been attempted through the use of radioisotopes. Predator-prey relationships, physiological problems, research on insecticides, including the systemics, and control studies have all been aided by this new tool. Although this review is not limited to work done solely in Canada an effort is made to include as much Canadian work as possible. Since the number of researchers using radioisotopes is small in Canada the reader may wish to refer to work done elsewhere. A number of excellent reviews on the subject are available (Jenkins and Hassett, 1950; Lindquist, 1952; Dahm, 1953; Hinton, 1954; Metcalf, 1954; Pendleton, 1956; Jenkins, 1957; and Dahm, 1957).

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* Affiliated to the Agricultural Institute of Canada.
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Methods of Rendering Insects Radioactive

Two of the first problems confronting an entomologist using a radioactive isotope are the choice of a suitable radioisotope and the method of making the insect radioactive. The selection of a suitable isotope depends on its cost and availability, the type and energy of radiation it emits, its physical and biological half-lives, its radiotoxicity, and its metabolic characteristics.

One of the limitations in biology is the lack of suitable radioisotopes of oxygen and nitrogen. Radioisotopes of these elements are known but their half-lives are too short to be of practical value.

The most commonly used isotope in tracer work in entomology is phosphorus-32, often called the "beginner's isotope". Phosphorus-32 has an energetic beta-particle (average energy 1.7 million electron volts), has a relatively short physical half-life (14.3 days), is readily incorporated into insects, and lacks gamma radiation. It can be detected by almost any type of particle counter with little danger of personal radiation exposure or long-term contamination. Its short half-life, however, makes it unsuitable for studies requiring long periods of observation, such as are necessary in hibernation studies. A radioisotope producing a more penetrating radiation is required for studies involving the movement of buried or hidden insects. Gamma-emitters, such as cobalt-60, may then be chosen.

The methods of making insects radioactive have received considerable attention by investigators. The radioisotope must be placed in or on the insect in such a way that it will not interfere with normal behaviour. Feeding the isotope is most desirable in some species. Phosphorus-32, for example, may be mixed with the natural or artificial food and fed directly to the insect. For example, Hoffman et al. (1951) and MacLeod and Donnelly (1957) obtained radioactive by the addition of radiophosphorus. Mosquitoes have been made radioactive by feeding on the blood of rats that were injected with P^{32} (Yates et al., 1951). The plum curculio was made radioactive by feeding on peach foliage, which took up radiophosphorus and radiostrontium when terminals were placed in solutions containing these radiochemicals (Rings and Layne, 1953). Riegert et al. (1954) tagged grasshoppers by allowing them to feed on radioactive wheat seedlings, and Cornwell (1956) similarly labelled mealybugs which fed on radioactive cacao seedlings.

Many workers, including Bugher and Taylor (1949), Hassett and Jenkins (1949), Jenkins and Hassett (1951), and Shemanchuk et al. (1953), obtained adults of various species of mosquitoes by rearing the larvae in solutions containing P^{32}. Fredeen et al. (1953) obtained radioactive adults of black flies by rearing the larvae in a dilute solution of P^{32}. Hoffman et al. (1951) and Radcliff et al. (1952) reared screw-worm larvae in artificial media containing P^{32} and the latter authors labelled the adults by rearing the larvae in natural hosts, such as sheep and goats, which had been injected intravenously with P^{32}.

A hazardous procedure was attempted by Foott (1954), who sprayed adults of the cabbage maggot with a P^{32} solution. Better results were obtained when the flies were allowed to feed on a radioactive sugar solution.

Roth and Hoffman (1952) dipped the house fly and blow flies for ten seconds in a solution containing five microcuries (μc) of P^{32} and a wetting agent. The radioactivity obtained was measurable for 18 days. When the flies were dipped for 60 seconds in a 12.5 μc solution the radioactivity was considerably increased.

Babers et al. (1954), in preliminary work, placed the boll weevil in an aluminium tea caddy and immersed the insects in a solution of cobalt-60 chloride in dilute hydrochloric acid to which a wetting agent had been added.

Knapp et al. (1956) made the lone star tick radioactive by pouring P^{32}-labelled sodium dihydrogen phosphate of ten μc per ml. specific activity, plus a wetting agent, over the ticks in a buchner funnel. Sufficient amounts of activity were present to enable identification in a study of the overwintering habits of this pest.

Using a submerging method, Davis and Nagel (1956) treated 19,000 adults of the Engelmann spruce beetle with sodium iodide-131 and a wetting agent. After evaporation, only the isotope and salts contained in the isotope solution were left. Mortality by the following day was 15 per cent; which is not considered excessive. The behaviour of the treated individuals could not be distinguished from the untreated in the laboratory.

Oughton (1951) tagged root maggot simply by pouring P^{32} into the soil at the bases of turnips. Three weeks later three radioactive flies were captured and six radioactive immature forms were found.

Arnason et al. (1950) and Fuller et al. (1951) studied the behaviour of wireworms and cutworms in the soil. Cobalt-60 wire 1 mm. in length, 0.250 mm. in diameter, and 0.5 mg. in weight with an initial activity of 0.022 milli-curies (mc.) was attached to the larvae, soil contamination through excretion being avoided in this way. External attachment was satisfactory only between moults, the activated wire being shed at each ecdysis. Internal insertion of the wire caused high mortality to wireworm larvae but less mortality to cutworm larvae. Death was due to puncturing of the digestive tract which resulted in cobalt poisoning. Frederickson and Lilly (1955), in a study of the reactions of wireworms to the four insecticides lindane, aldrin, dieldrin, and heptachlor, attached to the larvae with a cement spray Co^{60} wire 1 mm. in length, 0.5 mm. in diameter, and with an initial activity of 0.07 mc.

An interesting aspect of these studies was the method by which the radioactive specimens were detected, vertical and horizontal movements being recorded at the same time. The movements were read on a radiation detector calibrated from known soil depths, the position to within a quarter of an inch being possible at depths of five inches. At greater depths the accuracy fell off. In early work, the horizontal position was obtained by passing the radiation detector over the surface of the soil and finding the zone of maximum intensity. Later Green and Spinks (1955) developed an automatic plotting device for recording the movement of soil insects in three spatial dimensions and in time. This machine was capable of following a wireworm tagged with 20 μc. of Co^{60} for a distance of 15 inches through four inches of soil with an average position error of 0.25 inches. In 1958 the same investigators used a motion picture camera on the original machine to record by lapse-time photography the path taken by a wireworm.

Sullivan (1953) tagged adults of the white-pine weevil with Co^{60} to follow their movements before they hibernated. The Co^{60} metal was dissolved in nitric acid, dried, and redissolved in acetone, and cellulose acetate was then added to form a liquid adhesive. This radioactive material was then applied to the elytra of the insects. Cellulose cement was an efficient adhesive in the fall of the year but peeling of the radioactive material increased in the spring.

Green et al. (1957) applied cobalt-60-nitrate to the dorsal abdominal surfaces of adult females of the European pine shoot moth to study their dispersal. Each insect carried between 25 and 50 µc. of Co^{60}, which was detectable at a distance of at least three feet with a portable probe. The tags did not hinder movement of the insect bodies for oviposition or appear to hinder normal flight.

In a study of the behaviour of coccinellid larvae, Banks (1955) attached tantalum-182 wire with glue to the prothorax of newly-hatched larvae, increasing the weight by 24 per cent, but the behaviour was apparently normal.

Zeid et al. (1953) administered C^{14}- labelled pyrethrins to the American cockroach by interspiracular perfusion and by injection into the haemocoele. The injection method has been used also by Bergold (1954), Morrison and Oliver (1949), March et al. (1956), Robbins and Dahm (1955), LeRoux and Morrison (1954), and others. Insects have also been made radioactive by topical applications, especially in insecticide studies (Lindquist et al., 1951; Winteringham et al. 1951; Robbins and Dahm, 1955; Terriere and Schonbrod, 1955; Lindquist and Dahm, 1956 and others).

Research on Insecticides and Physiology

Radioactive materials as tracers have been used in studies concerning the penetration, distribution, accumulation, metabolism, and excretion of elements in the insect body. Many labelled compounds can be prepared at specific activities such that they may be detected, or "traced" at very high dilutions. For example, the methods of detecting P^{32} are millions of times more sensitive than the methods for detecting the stable isotope of this element. Besides this great sensitivity, the tracer technique has the added advantage of specificity.

The provision of radioactive insecticides has enabled toxicologists to study their effects against various insects. DDT labelled with carbon 14 was prepared by Fields et al. (1950) in the United States and by MacDonald and Baker (1953) in Canada. DDT labelled with bromine-82 was prepared by Winteringham et al. (1950) in England. Pellegrini et al. (1952) synthesized pyrethrins by growing the plant in $C^{14}O2$ for 46 days. Acree et al. (1954) synthesized C^{14} allethrin for metabolic studies with the house fly and cockroaches.

Metcalf et al. (1954) studied the behaviour of the thiono isomer and the thiol isomer of demeton labelled with P^{32} and S^{35} in bean and lemon plants. A single toxic metabolite comprised about 90 per cent or more of the initial metabolic products for each of the isomers.

Metcalf et al. (1956) studied the systemic behaviour of the thiol isomer and its sulphoxide and methosulphate derivatives in the cotton plant. The latter derivative penetrated the plant cuticle very slowly and therefore accumulated slowly. The accumulation in the leaves of the plants of radioactive materials for the thiol isomer was more rapid for the first 14 days but after that the sulphoxide treatment gave the higher values. Using the P^{32}-labelled thiono isomer of demeton, Fukuto et al. (1957) found a secondary metabolite, thiono isomer sulphone, in cotton plants. This metabolite comprised about 15 per cent of the total radioactivity.

Pietri-Tonelli and March (1954), using P^{32}-labelled schradan, showed that schradan is metabolized in the insect to other compounds, including an active metabolite which is responsible for toxicity.

In distribution and accumulation studies, Irwin et al. (1950) found radiophosphorus to be heavily concentrated in the fat body, nervous structures, and organs of digestion and excretion of the fruit fly. In the adults the gonads also contained considerable P^{32}. Fang and Allen (1955) found that P^{32} was least concentrated in the fat body of the Douglas-fir beetle. Lindsay and Craig (1942) found that P^{32} soon appeared as various phosphoric compounds in four species of insects. Rodriguez (1954) reported that a rather large amount of radiophosphorus accumulated in the eggs of the two-spotted mite. Grosch and Sullivan (1953) had previously found that most of the isotope (P^{32}) fed was incorporated into the eggs of the wasp *Habrobracon* sp. and eliminated by this route.

Roan et al. (1950) studied the permeabilities, transport, and metabolism of four organic phosphates in the American cockroach. The highest concentration of TEPP or its metabolite was found in the foregut. After topical application the concentration rose rapidly in the blood at first, then fell sharply. Of the four phosphates tested, TEPP was distributed and excreted from the body faster than any of the others.

Since it was established that physiological differences existed between DDT-susceptible and DDT-resistant house flies many experiments with radioactive materials have been conducted to ascertain the details of these differences. Winteringham et al. (1951) studied the penetration and metabolism of the bromine analogue of DDT in the house fly by using an analogue labelled with radioactive Br^{82}. Five hours after a topical application on the dorsal surface of the thorax 29 per cent of the total weight of the Br^{82}-labelled DDT was absorbed by susceptible flies and five per cent by resistant flies. In surviving flies Lindquist et al. (1951) recovered 63 per cent of the total C^{14} DDT absorbed from topical applications as a non-toxic metabolite and Terriere and Schonbrod (1955) showed that susceptible and resistant flies were similar in their detoxification and excretion capacities. LeRoux and Morrison (1954) stated that resistance to DDT was a complex phenomenon due to slower penetration and distribution, more rapid elimination, and some factors other than detoxification. They applied C^{14} DDT directly to the site of action, the head, and still produced less mortality in the resistant strain.

Using C^{14} DDT in the American cockroach, Robbins and Dahm (1955) found that the fore-gut, the hind-gut plus the Malpighian tubules, and fat contained the greatest amount of radioactivity. As much as 75 per cent of the DDT applied was excreted as DDT or its metabolites in the feces over a 24-day period. Lindquist and Dahm (1956), working with the Madeira cockroach, which can tolerate larger dosages of DDT than the American cockroach, showed that 90 per cent of the DDT applied was absorbed in 20 days and that 40 to 50 per cent of the DDT applied topically was retained within the cockroaches as DDT and metabolites for extended periods.

March _et al._ (1956) studied P^{32}-labelled malathion in the laying hen, the white mouse, and the American cockroach. Chromatograms of malathion and metabolites prepared from extracts of these three animals indicated a considerably less complex and less effective metabolism in the insect. They suggested that this may explain the great differential in toxicity for malathion between insects and warm-blooded animals. Apparently most of the metabolites formed in warm-blooded animals are of a low order of toxicity. The inability of the insect to form such metabolites undoubtedly contributes greatly to the effectiveness of malathion as an insecticide.

Dispersal Studies

It has been difficult in the past to mark large numbers of insects for studies on movement in the field. The use of radioisotopes has materially assisted the worker in this field of entomological research. Bugher and Taylor (1949) stated that a number of conditions must be met for an ideal working procedure: (a) There should be a minimum of manipulation of the population, or none at all; (b) The marker must be easily applied to a large population; (c) The marker should be easily recognized and persist throughout the experiment; and (d) the marker should have no deleterious influences. The technique of tagging with radioisotopes has approached these conditions much more closely than the older methods. Marking with bright dyes, metallic dusts, or other visible marking agents is still of value for many studies and is combined with radioisotopes in many insect dispersal studies.

Phosphorus-32 has been particularly useful in studies on insect dispersion and flight range, but strontium-89, cobalt-60, iodine-131, scandium-46, sulphur-35, chlorine-36, calcium-45, and zinc-65 have also been used successfully.

Large numbers of mosquitoes have been tagged and released by a number of workers but recovery has been light. In Nigeria, Bugher and Taylor (1949) released 276,000 adults of the yellow-fever mosquito and recovered 0.11 per cent. The maximum flight range of recovered specimens was three-quarters of a mile. At Churchill, Manitoba, Jenkins and Hassett (1951) released 3,000,000 radioactive sub-arctic mosquitoes and recovered 141 of them; the maximum flight range was 5,000 feet. In Western Canada Shemanchuk et al. (1953) tagged 470,000 larvae of four species of mosquitoes and recovered only three radioactive adults. In 1955 Shemanchuk et al. released 415,000 mosquitoes and recovered less than one per cent; the maximum flight range was 6.6 miles. In the southern United States, Quarterman et al. (1955) released 50,000 radioactive adults of two species of rice field mosquitoes and recovered 44 specimens; one specimen travelled at least six miles.

The percentage recovery of the house fly and blow flies was somewhat better. Lindquist et al. (1951) recovered 14 per cent of a blow fly, and 4.6 per cent of the house fly. Other workers obtained smaller recoveries. The maximum flight range varied from eight miles (Lindquist et al., 1951) to 28 miles (Yates et al., 1952) for blow flies, and from three miles (Schoof et al., 1952) to 20 miles (Yates et al., 1952) for the house fly.

Pimental and Fay (1955) recovered fruit flies a distance of 500 to 1,000 feet from the point of release.

Davis and Nagel (1956) treated 19,000 adults of the Engèlmann spruce beetle with I^{131} and approximately five per cent were later located by their radioactive tag. Green et al. (1957) tagged 106 adult females of the European pine shoot moth with Co^{60}. The following day 40 per cent were located and one week later 26 per cent were taken. Godwin et al. (1957) treated 1,600 adults of the white-pine weevil with Sc^{46}. The weevils were released in the fall and the following spring 109 living weevils were recovered; winter mortality was high.

Rings and Layne (1953) labelled the plum curculio and released 678 beetles in the fall. The following spring 59 radioactive specimens were recovered. Jones and Wallace (1955) found that cherry fruit fly adults were detectable up to six weeks after they were made radioactive with P^{32}; of 2,010 radioactive flies released, 39 were recovered, and one was taken 942 feet from the point of release. Foott (1955) released 1,854 radioactive adults of the cabbage maggot and recovered two.

Studies on Transmission of Diseases by Insects

Mention should be made of the role of radioisotopes in studies on the transmission of disease by insects. Hamilton (1935) first showed the value of radioisotopes in studies of this nature by using polonium-212 in aphids. Rodriguez (1954) showed that leaf discs became radioactive when fed on by radioactive two-spotted mites, indicating that a secretion containing phosphorus was injected into the leaf. Lawson et al (1954) found that tobacco leaves on which the green peach aphid had fed became radioactive. The radiophosphorus was translocated to other parts of the plants. The aphids also excreted radioactive honeydew and feces.

Bergold (1954) injected polyhedral virus suspended in C^{14}-labelled alanine and glycine into silkworm larvae. The beta-radiation inhibited the virus multiplication and 40 per cent of the larvae overcame the virus infection and developed to adults. The radioactive polyhedral bodies gave counts of 1,300 per minute per milligram and the virus particles liberated from the polyhedral bodies gave 3,800 c.p.m. per mg.

Predator-Prey Relationship Studies

The evaluation of predators that feed on a number of species is a difficult problem. When a radioactive pest is eaten by a predator a radioactive record is left in the latter animal. Ahmed et al. (1954) showed that syrphid fly larvae, coccinellid larvae, and chrysopid larvae all became radioactive after feeding on aphids that had fed on radioactive cotton plants.

Many investigators report incidental predation in radioisotope studies but Baldwin et al. (1955) made the first serious attempt to identify predators of mosquito larvae and pupae by means of radioisotopes. Mosquito larvae and pupae made radioactive with P^{32} were released into a natural environment and predators were collected one day later. Three new records of predators of mosquitoes were established.

In preliminary work at Kentville the author exposed to predation in apple orchards radioactive eggs and larvae of the codling moth in all stages of development, and later collected predators at various intervals. Coccinellids, pentatomids, nabids, chrysopids, mirids, thrips, ants, anystid and Atomus mites, and spiders fed on the eggs or larvae. In a laboratory study 21 species of spiders fed upon spruce budworm larvae made radioactive by feeding on balsam-fir foliage treated with P^{32}.

Control of Insects with Radiation

A number of insects have been studied concerning the effects of radiation and were found to be many times more resistant than vertebrates; resistance to radiation increased steadily with development and age. Arnason et al. (1949), using P^{32} in culture media, found that fruit fly larvae could be killed with 0.65 rutherfords or more per millilitre of food. Most deaths occurred in the late larval or pupal stages. Sullivan and Grosch (1953), in subjecting *Habrobracon* wasps to x-ray doses up to 180,250 roentgens (*r*), found that the insects became sluggish and all body movements were decreased. However, recovery was relatively rapid and all insects appeared normal within half an hour. Heidenthal (1945), however, obtained 100 per cent mortality using 300,000 *r* against *Habrobracon* males.

Jaynes and Godwin (1957) obtained an acceptable level of egg sterility in the white-pine weevil with 5,000 to 10,000 *r* of gamma radiation from Co^{60}. As the dosage was increased the life span of the weevils was progressively shortened and the rate of oviposition was greatly diminished.

Bletchly and Fisher (1957) studied the control of woodboring insects by irradiation. Eggs of the furniture beetle and the death-watch beetle were killed at 4,000 *r* of gamma radiation from Co^{60} if irradiated within four days of laying. However, resistance increased rapidly with development and dosages between 48,000 and 68,000 *r* were necessary to kill mature eggs of the furniture beetle, and above 32,000 *r* for mature eggs of the death-watch beetle. High dosages of gamma radiation killed larvae of a powder-post beetle but development was stopped at 8,000 *r*. No fertile eggs were laid by any of the three species when adults were treated with 8,000 *r* although treatment of 48,000 *r* to adult females of the powder-post beetle did not inhibit egg-laying.

In a study of 17 stored product insect species, Cornwell et al. (1957) obtained variable results. Immature stages irradiated at 20,000 *r* showed a reduction in emergence and the survivors were sterile. At 50,000 *r* very few developed to adults. All adults of one species were killed in ten days after receiving dosages of 20,000 *r* whereas in three species light to heavy mortality occurred and in another four species no lethal effects were observed. Marked differences were found in the tolerance of various species but 13 of them were sterilized by a dosage of about 6,000 *r* and all species irradiated at 3,000 *r* showed a significant reduction in fertility. Doses greater than 20,000 *r* were required to prevent the emergence of adults from irradiated pupae.

Bushland and Hopkins (1951 and 1953) showed that 5,000 r of x-ray or gamma ray would sterilize pupae of the screw-worm without apparently affecting mating behaviour. Females of this fly mate only once. The island of Curacao, off the coast of Venezuela, containing 170 square miles and having a high screw-worm population, was chosen for a large scale field eradication experiment (Lindquist, 1955; Baumhover *et al.*, 1955). Sterilized males were released at 400 per square mile per week for seven weeks and caused an initial sterility of about 70 per cent. This increased to 100 per cent as the number of flies and egg masses declined. Six months after the last egg mass was found there was still no evidence of normal flies and it was concluded that the screw-worm was eradicated from the island of Curacao.

At the present time Dr. M. D. Proverbs (personal communication), Entomology Laboratory, Summerland, British Columbia, is exploring the possibilities of controlling the codling moth through the release of sterile males. Eggs from females that were irradiated with 5,000, 7,500, and 11,000 r of gamma radiation (C^{60}) as 8-day-old pupae gave hatches of 7, 0.8, and 0.4 per cent respectively, as compared with 69 per cent in the controls.

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p.414 - paragraph 2, line 13, for "favourable" read
"unfavourable"

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